OPERATING AND PROGRAMMING INSTRUCTIONS

PLEASE NOTE

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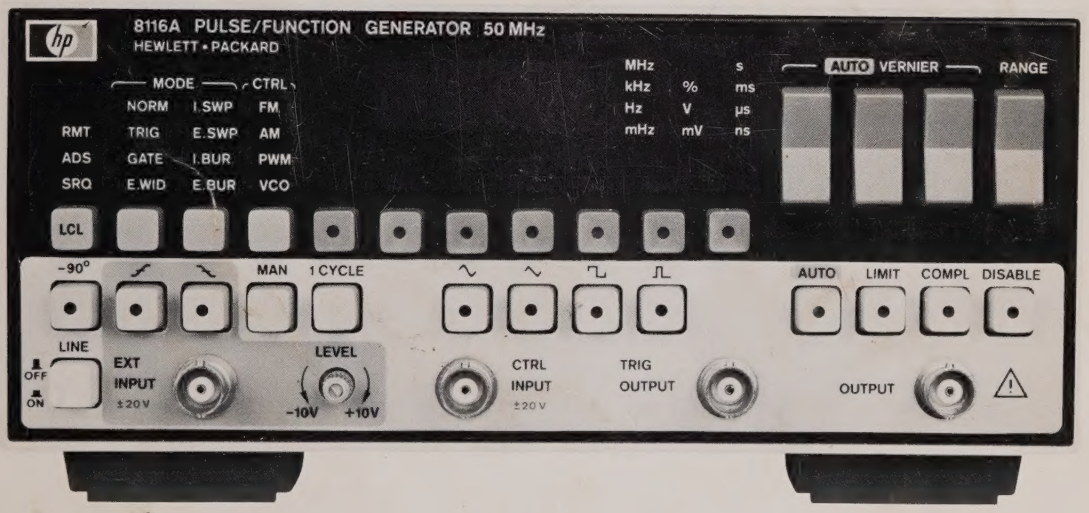
PLEASE RETURN MANUAL AND ACCESSORIES WHEN RETURNING EQUIPMENT.

CONTINENTAL RESOURCES, INC.
175 Middlesex Turnpike, Bedford, MA.01730

8116A PROGRAMMABLE PULSE/FUNCTION GENERATOR 50 MHz



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CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

For products returned to HP for warranty service, Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

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Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND PROGRAMMING INSTRUCTIONS

8116A PROGRAMMABLE PULSE/FUNCTION GENERATOR 50 MHz

(Including Option 001)

This manual applies directly to all instruments.

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HERRENBERGER STR. 110, D-7030 BÖBLINGEN
FEDERAL REPUBLIC OF GERMANY

MANUAL PART NO. 08116–90000

PRINTED: NOVEMBER 1981

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

GENERAL – This is a Safety Class I instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

OPERATION – BEFORE APPLYING POWER comply with the installation section. Additionally, the following shall be observed:

Do not remove instrument covers when operating.

Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present. Do not replace components with power cable connected.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not install substitute parts or perform any unauthorized modification to the instrument.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

SAFETY SYMBOLS

The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.

Indicates dangerous voltages.

Earth terminal

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

WARNING

Dangerous voltages, capable of causing serious personal injury, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

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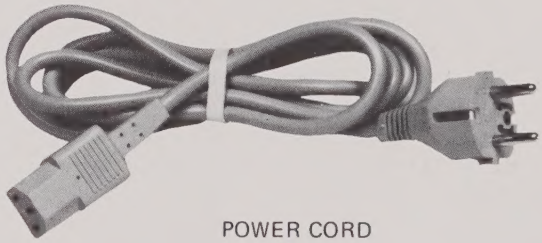
8116A

FUSE



POWER CORD

Figure 1–1. 8116A and Supplied Accessories (Instrument shown with Option 001 fitted).

SECTION I
GENERAL INFORMATION

1–1 INTRODUCTION

1–2 This manual contains information required to install, operate and test the Hewlett-Packard Model 8116A. This section covers instrument identification, description, accessories, specifications and other basic information.

1–3 SPECIFICATIONS

1–4 Instrument specifications are listed in Table 1–2. These specifications are the performance standards or limits against which the instrument is tested.

1–5 SAFETY CONSIDERATIONS

1–6 The 8116A is a Safety Class 1 instrument (it has an exposed metal chassis that is directly connected to earth via the power supply cable). Before operation, the instrument and manual, including the red safety page, should be reviewed for safety markings and instructions. These must then be followed to ensure safe operation and to maintain the instrument in a safe condition.

1–7 DESCRIPTION

1–8 The HP 8116A Programmable Pulse/Function Generator operates over the frequency range 1 mHz to 50 MHz and up to 32 V peak-to-peak amplitude. Capabilities include:

- Multiwaveform generation (sine, square, triangle, pulse)
- 6 ns transition time for pulse and square-wave
- Variable pulse width down to 10 ns
- AM/FM/PWM modulation modes
- VCO control mode
- Fully HP-IB programmable
- Internal and external logarithmic sweep (Opt. 001)
- Internal and external burst mode for all waveforms (Opt. 001)

1–9 A unique self-prompting operating concept, plus the full HP-IB programmability, provide an easy means to execute single manual operation or complex automatic tasks.

1–10 Correct functioning is assured by the automatic self-test and error recognition capabilities. Self-test and diagnosis are performed each time the instrument is switched on. Error recognition helps the operator recover from an incorrect frontpanel or programming operation.

1–11 8116A Options.

1–12 Option 001. The 8116A can provide increased capabilities with the addition of Option 001. Added capabilities include:

- Logarithmic sweep (selectable internal or external triggering)
- Counted burst (selectable internal or external triggering)
- Hold input for sine, triangle and squarewave.

1–13 ACCESSORIES SUPPLIED

1–14 The 8116A is supplied complete with the following items:

ITEM	HP PART NUMBER
750 mA fuse for 220/240 V operation or, 1.5 A fuse for 100/120 V operation	2110–0063 2110–0043
Power cable	See Figure 2–2

1–15 ACCESSORIES AVAILABLE

ITEM	HP PART NUMBER
Carrying handle – Bail Handle Kit	5061–2001
Rack mounting adaptors: Rack mounting flange and filler panel for rack mounting a single 8116A.	5061–0072
Rack mounting flange and lock link kit for rack mounting two 8116A's	5061–0074 5061–0094

1–16 RECOMMENDED TEST EQUIPMENT

1–17 Equipment required to maintain the 8116A is listed in Table 1–1. Alternative equipment can be substituted provided that it meets or exceeds the critical specifications listed in the table.

Table 1–1. Recommended Test Equipment

Instrument	Recommended Model	Required characteristics	Adequate Substitute	Use*
Counter	HP 5335A	50 MHz, Start/Stop, TI, A to B	HP 5345A + HP 5363B	P, A P, A
DVM	HP 3455A	DC .1 V–50 V, .004 % acc.	HP 3456A	P, A
DVM	HP 3465A	AC .1 V–50 V	HP 3456A	P, A, T
Signal Generator	HP 3325A	20 MHz, THD ≤ .1 %		P, A
Function Generator	HP 8111A	20 MHz, sine, pulse		P
Real Time Scope	HP 1740A	100 MHz Bandwidth	HP 1743A	P, A, T
Sampling Scope	TEK 7603 with 7T11/7S11 and S–3A	1 GHz	HP 140A/ 1410A	P, A
Spectrum Analyzer	HP 3580A	5 Hz – 50 kHz	HP 3585A	P, A
Spectrum Analyzer	HP 181T/ 8557A	50 MHz		P
Signature Analyzer	HP 5005A		HP 5004A	T
Logic Probe	HP 545A	TTL		T

* P = Performance Test; A = Adjustments; T = Troubleshooting

Table 1–2. Specifications

The following specifications apply with 50 Ohm load resistance. Output levels double when driving into high impedance (up to 32 Vpp).
Accuracy specifications apply from 15° C to 35° C. For temperatures below 15° C and above 35° C see "General" information.

WAVEFORMS

Sine, Triangle, Ramp, Square, Pulse, Haversine, Havertriangle, DC

TIMING CHARACTERISTICS

Frequency

Range: 1.00 mHz to 50.0 MHz
Resolution: 3 digits

Accuracy (% of setting)	Pulse mode or 50% duty cycle	= 50% duty cycle
1.0 mHz to 99.9 kHz	± 3% ± 0.3 mHz	± 3% ± 0.6 mHz
100 kHz to 9.99 MHz	± 5%	± 10%
10.0 MHz to 50 MHz	± 5%	---

Repeatability: Factor 4 better than accuracy
Jitter: < 0.1% + 100 ps (50% duty cycle and pulse mode)
< 0.2% + 100 ps (= 50% duty cycle)
Stability: ± 0.2% (1 hour)
± 0.5% (24 hours)

Duty Cycle (sine, triangle, square)

Range: 10% to 90% (1 mHz to 999 kHz)
20% to 80% (1 MHz to 9.99 MHz)
Resolution: 1%
Accuracy: ± 0.5 digits (100 mHz to 999 kHz)
± 3.0 digits (1 MHz to 9.99 MHz)

Pulse Width (pulse mode)

Range: 10.0 ns to 999 ms
Resolution: 3 digits
Accuracy: ± 5% of setting ± 2 ns
Repeatability: Factor 4 better than accuracy
Jitter: 0.2% + 200 ps (width ≤ 10 μs)
0.1% (width > 10 μs)
Max. Width: Period – 10 ns

OUTPUT CHARACTERISTICS

Output Impedance: 50 Ohm ± 5%
Reflection: < 12% (ampl. ≥ 100 mVpp)

Amplitude/Offset

Amplitude and offset are independently variable within the following two level windows

Level window	± 800 mV	± 8.00 V
Amplitude range	10.0 mVpp to 99.9 mVpp	100 mV pp to 16.0 Vpp
Ampl. resolution	3 digits	3 digits
Ampl. accuracy*	± 5% [0.45dB]	± 5% [0.45dB]
Repeatability	Factor 4 better than accuracy	
Offset range	0 to ± 795 mV	0 to ± 7.95 V
Offset resolution	3 digits (best case 100 μV)	3 digits (best case 1 mV)
Offset accuracy	± 0.5% of setting ± 1% of amplitude ± 2 mV	± 0.5% of setting ± 1% of amplitude ± 40 mV
Repeatability	Factor 4 better than accuracy	

*The amplitude accuracy for sine and triangle is specified at 1 kHz. For other frequencies see the following flatness specifications

Amplitude Flatness (50% duty cycle)	Sine	Triangle
1.00 mHz to 999 kHz	± 3% [0.26 dB]	± 3%
1.00 MHz to 9.99 MHz	± 5% [0.45 dB]	± 5%
10.0 MHz to 50.0 MHz	+ 5% [0.45 dB] – 15% [1.41 dB]	+ 5% – 25%

DC Voltage (all waveform selection keys deactivated)

Range: 0 to ± 7.95 V
Resolution: 3 digits (best case 1 mV)
Accuracy: ± 0.5% of setting ± 20 mV

WAVEFORM CHARACTERISTICS

Sine (Normal Mode, 50% duty cycle)
Total Harmonic Distortion (THD): < 1% [-40 dB], (10 Hz to 50 kHz)
Harmonic Signals: More than 34 dB below fundamental (50 kHz to 1 MHz)
More than 23 dB below fundamental (1 MHz to 50 MHz, < 8 Vpp amplitude)
THD may increase by 3dB below 10°C

Triangle, Ramp

Non-linearity: < ± 3% (10% to 90% of amplitude, 100 mHz to 1 MHz)

Square, Pulse

Rise/Fall time: < 6 ns (10% to 90% of amplitude)
Pulse Perturbations: < ± 5% of amplitude ± 2 mV

OPERATING MODES

Norm: Continuous waveform is generated
Trig*: Each input cycle generates a single output cycle
Gate*: External signal enables oscillator. First output cycle synchronous with active trigger slope. Last cycle always completed.

External Width: (pulse mode only) External signal will be shaped to determine output pulse width and period. Amplitude and offset controls are active.

Sweep: (opt. 001 only) Logarithmic sweep for all waveforms up to full range (1 mHz to 50 MHz) between selected start and stop frequency. Sweep time per decade selectable in 1-2-5 sequence between 10 ms and 500 s.
Int. Sweep: Continuous sweep cycles
Ext. Sweep: One sweep cycle generated on receipt of external signal.

Burst*: (opt. 001 only) Preprogrammed number of periods (1 to 1999) is generated. Minimum time between bursts is 100 ns. For bursts with only one period, min time between bursts is 0 ns
Int. Burst: (pulse mode not available)
Internally generated signal starts burst.
Repetition time: 20 ns to 999 ms
Ext. Burst: (all waveforms)
External signal starts burst

*Startphase of sine and triangle switchselectable to 0° and -90° for haversine and havertriangle

Table 1–2. Specifications

AUXILIARY OPERATING MODES

Man: Simulates external input.
1 Cycle: (Opt 001 only) Provides a single output period in TRIG, GATE and EXT BURST mode.

Auto: In NORM mode, all parameters can be automatically incremented or decremented with selectable resolution. Pushing the AUTO button activates the AUTO vernier, which then can be started with the selected vernier key. AUTO vernier stop is accomplished by an external trigger input or pushing AUTO.

Limit: Maximum high and low levels into 50 Ohm can be limited to protect the device under test. Pushing the limit key will set the limits to the actual levels, which then cannot be exceeded as long as the mode is active.
Compl: Switchselectable normal/complement output.
Disable: Relay disconnects all output circuitry

CONTROL MODES (external voltage modulates output signal)

FM (frequency modulation)
Deviation: ± 5% max
Sensitivity: 1V for 1% deviation
Modulation bandwidth: dc to 20 kHz

AM (amplitude modulation)
Sensitivity: ± 2.5V for 100% modulation depth
+ 2.5V, -7.5V for DSBSC
Modulation bandwidth: dc to 1 MHz
Envelope distortion: < 1% for modulation depth less than 90% (dc to 50 kHz)
PWM (pulse width modulation)
Pulse width ratio: 10:1 max
Sensitivity: ≥ ± 6 V for ratio 10:1.
Pulse width ranges: 10 ns to 1 s in eight nonoverlapping decade ranges

VCO (voltage controlled oscillator)
External voltage linearily sweeps 2 full frequency decades.

Modulation range: 1:100 with 0.1V to 10V
Modulation bandwidth: dc to 1 kHz

SUPPLEMENTARY PERFORMANCE CHARACTERISTICS

(Supplementary characteristics are intendend to provide information useful in applying the instrument by giving non-warranted typical performance parameters)

AUXILIARY INPUTS AND OUTPUTS

Ext. Input Threshold level: ± 10V adjustable
Max input voltage: ± 20V
Sensitivity: 500 mVpp
Min pulse width: 10 ns
Input impedance: 10 kOhm
Trigger slope: pos./neg. and trigger off

Control Input Max input voltage: ± 20V
Input impedance. 10 kOhm
Trigger Output Output levels: 0/2.4V into 50 Ohm
0/4.8V into open
Output impedance: 50 Ohm

X-Output (Opt 001 only): Increasing X-Output voltage with increasing sweep frequency. 0V corresponds to start frequency and slope is 1.5V/frequency decade. The max. output voltage ist 10V.

Marker Output (Opt 001 only): TTL compatible voltage with positive transition at selected marker frequency

Hold Input (Opt 001 only): Main output will hold at the instantaneous voltage level when input signal becomes TTL high. Applicable for sine, triangle and square below 10 Hz.
Droop: 0.01% of amplitude/s
Max input voltage: ± 20V

HP-IB CAPABILITY

All modes and parameters can be programmed. The external input threshold level is not programmable.

Programming Times

Listen (time for 8116A to receive and verify message)
Modes, Waveforms, Norm/Complement, Disable/Enable: 30 ms
Frequency, Duty Cycle, Width: 50 ms
Amplitude, Offset, Levels: 250 ms

Talk (time for 8116A to transmit a message)
Status: 1 byte (indicates nature of programming error): 15 ms
Learn: 10 lines (16 with Opt. 001) up to 14 characters plus CRLF: 15 ms/line average

Settling Times (time to execute message)
Frequency, Duty Cycle, Width, Amplitude: 5 ms
Offset, DC Voltage: 30 ms

GENERAL

Warm-up Time: 15 min to meet all specifications
Environmental:
Storage temperature: -40° C to 65° C
Operating temperature: 0° C to 55° C
Accuracy specifications apply from 15° C to 35° C.
Accuracy derating factor for temperatures outside this range: 1 + 0.05 x △° C.
△° C is the temperature deviation below 15° C and above 35° C.

Humidity Range: 95% R.H., 0° C to 40° C

Power-off-storage: After eight hours of operation, battery maintains all current mode and parameter information up to half a year with instrument switched off.
Power: 100/120/220/240 V rms +5%, -10%; 48-440 Hz; 120 VA max.
Weight: Net 5.9 kg (13 lbs), Shipping 8.0 kg (18 lbs)
Dimensions: 89 mm high, 213 mm wide, 450 mm deep (3.5 x 8.4 x 17.7 in)

Options:
001 Burst, Sweep and Hold
910 Additional Operating and Service Manual (Part No: 08116-90001)

SECTION II
INSTALLATION

2–1 INTRODUCTION

2–2 This section provides installation instructions for the instrument and its accessories. It also includes information about initial inspection and damage claims, preparation for use, and packaging, storage and shipment.

2–3 INITIAL INSPECTION

2–4 Inspect the shipping container for damage. If the container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1–1 plus any accessories that were ordered with the instrument. Procedures for checking the electrical operation are given in Section 4. If the contents are incomplete, if there is a mechanical damage or defect, or if the instrument does not pass the operator's checks, notify the nearest Hewlett-Packard office. Keep the shipping materials for carrier's inspection. The HP office will arrange for repair or replacement without waiting for settlement.

2–5 PREPARATION FOR USE

WARNING

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).

2–6 Power Requirements

2–7 The instrument requires a power source of 100/120/220 or 240 Vrms (+5 % – 10 %) at a frequency of 48–440 Hz single phase. The maximum power consumption is 120 VA.

2–8 ⚠ Line Voltage Selection

CAUTION

BEFORE SWITCHING ON THIS INSTRUMENT make sure that the instrument is set to the local line voltage. The line voltage selector switches an be seen through the lefthand side of the instrument cover to the rear. The correct setting for the country of destination will have been made at the factory. The instrument power fuse is located on the rear panel. To access the line selector switches, first DISCONNECT the power cord, then remove instrument top cover by releasing the captive securing screw at rear and sliding cover off.

CAUTION

Do not change the LINE SELECTOR switch settings with the instrument on or with power connected to the rear panel.

2–9 Figure 2–1 provides information for line voltage and fuse selection:

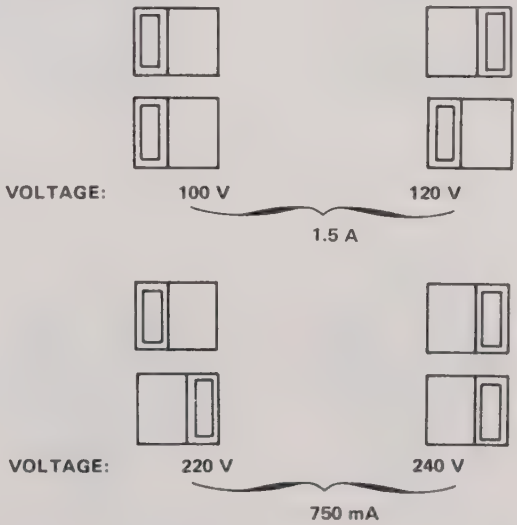


Figure 2–1. Sliding Switches Positions for different Line Voltages

2–10 Power Cable

WARNING

To avoid the possibility of injury or death, the following precautions must be followed before the instrument is switched on:

a. If this instrument is to be energized via an autotransformer for voltage reduction, make sure that the common terminal is connected to the grounded pole of the power source.

b. The power cable plug shall only be inserted into a socket outlet provided with a protective ground contact. The protective action must not be negated by the use of an extension cord without a protective conductor.

c. Before switching on the instrument, the protective ground terminal of the instrument must be connected to a protective conductor of the power cable. This is verified by checking that the resistance between the instrument chassis and the front panel and the ground pin of the power cable plug is zero ohms.

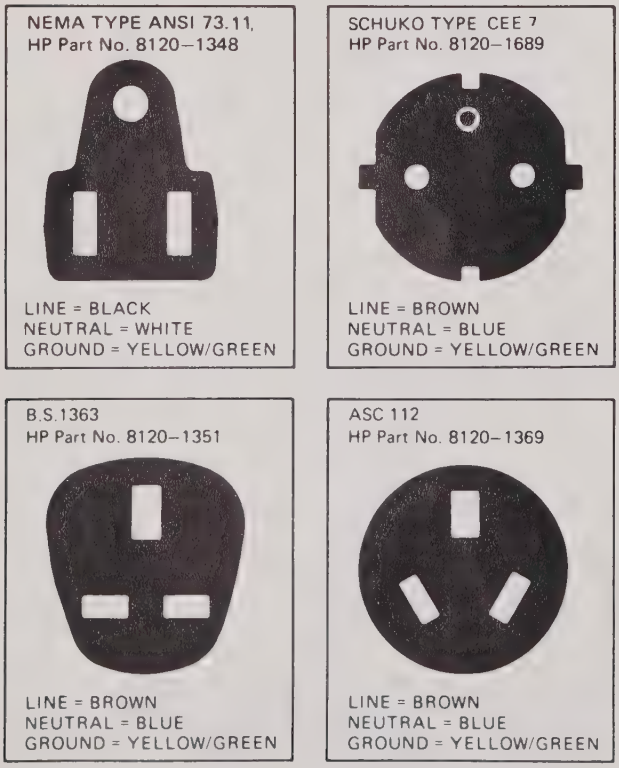


Figure 2–2. Power Cables Available: Plug Identification

2–11 In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 2–2 for the part number of the power cords available.

2–12 The following work should be carried out by a qualified electrician and all local electrical codes must be observed. If the plug on the cable supplied does not fit your power outlet, or if the cable is to be attached to a terminal block, then cut the cable at the plug end and re-wire it. The colour coding used in the cable will depend on the cable supplied (see Figure 2–2). If a new plug is to be connected, the plug should meet local safety requirements and include the following features:

adequate load-carrying capacity (see table of specifications in Section 1)

ground connection

cable clamp

2–13 HP-IB Connector

2–14 The rear panel HP-IB connector (Figure 2–3) is compatible with the connectors on Cable Assemblies 10833A, B, C and D. If a cable is to be locally-manufactured, use connector male, HP part number 1251–0293.

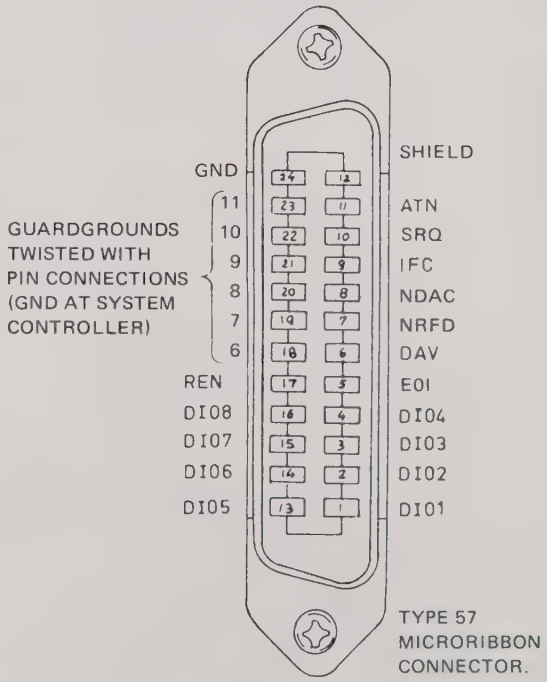


Figure 2–3. HP-IB Connector

2–15 HP-IB Logic Levels

2–16 The 8165A HP-IB lines use standard TTL logic. Logic levels are as follows:

True = low = digital ground or 0V dc to +0.4V dc,
False = high = open or +2.5V dc to +5V dc.

All HP-IB lines have LOW assertion ("1") states. High states are held at +3V dc by pullups within the instrument. When a line functions as an input, approximately 3.2mA of current is required to pull it low through a closure to digital ground. When a line functions as an output, it will sink up to 48mA in the low state and approximately 0.6mA in the high state.

CAUTION

Isolation. The HP-IB line screens are not isolated from outer chassis (frame) ground.

2–17 Operating Environment

The operating temperature limits are 0°C to 55°C. The specifications also apply over this temperature range.

2–18 CLAIMS AND REPACKAGING

2–19 Claims for Damage

2–20 If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

2–21 Storage and Shipment

2–22 The instrument can be stored or shipped at temperatures between −40°C and 75°C. The instrument should be protected from temperature extremes which cause condensation within it.

2–23 If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag showing owner, return address, model number and full serial number and the type of service required. The original shipping carton and packaging material may be re-usable
but the Hewlett-Packard Sales/Service office will also provide information and recommendations on materials to be used if the original packing is not available or re-usable. General instructions for re-packing are as follows:

1. Wrap instrument in heavy paper or plastic.

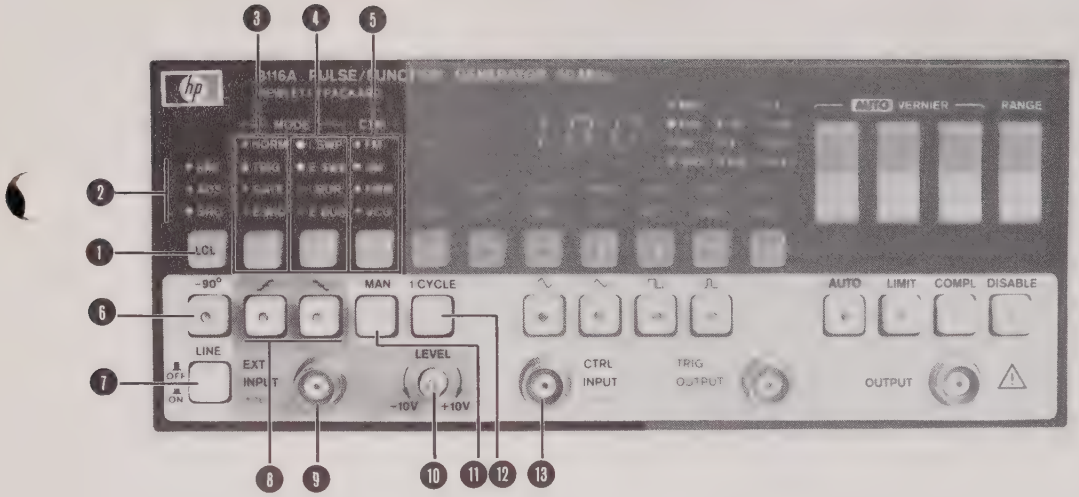
2. Use strong shipping container. A double wall carton made of 350-pound test material is adequate.

3. Use enough shock-absorbing material (3 to 4-inch layer) around all sides of instrument to provide firm cushion and prevent movement inside container. Protect control panel with cardboard.

4. Seal shipping container securely.

5. Mark shipping container FRAGILE to encourage careful handling.

6. In any correspondence, refer to instrument by model number and serial number.



OPERATING AND CONTROL MODE SELECTION

1 This pushbutton returns the 8116A to local manual operation. (NOTE: Pushbutton disabled when LOCAL LOCK-OUT command sent by the controller to the 8116A). in local mode pressing this pushbutton causes the currently selected HP-IB address to be displayed.

2 Program status LED's. When illuminated, they indicate the following:

RMT: Indicates remote control and all front panel pushbuttons are disabled (except LCL).

ADS: Indicates that the 8116A is under program control, although frontpanel pushbuttons could be operational depending if the RMT LED is illuminated or not.

SRQ: Indicates that the SERVICE REQUEST has been sent to the controller.

3 Standard mode selection pushbutton and associated LED's. Repetitive operation of this pushbutton steps through the modes in the sequence indicated by the LED column.

The modes are as follows:

NORM— Internal rate generator free-running.

TRIG— A trigger signal, either at the EXT INPUT connector or via the MAN pushbutton, initiates one output pulse.

GATE— A gate signal, either at the EXT INPUT connector or via the MAN pushbutton, generates an output for as long as the gate is present.

E.WID— (Pulse waveform only) External signal at the EXT INPUT connector is shaped to determine output pulse width and period.

4 Option mode selection pushbutton and associated LED's. Repetitive operation steps through the modes in the same sequence as the LED column. The modes are as follows:

I.SWP— Continuous sweep cycles between the selected start and stop frequency. Frequency increment is logarithmic. Sweep direction always upwards.

E.SWP— A trigger signal, either at the EXT INPUT connector or via the MAN pushbutton, generates a single sweep between the selected start and stop frequency. (Further triggering details given later in this section under External Triggering/MAN descriptions).

I.BUR— (Pulse waveform excluded). Preselected number of cycles (1 to 1999) generated continuously. Time between bursts set via RPT key.

E.BUR— (All waveforms). A burst trigger, either at the EXT INPUT connector or via the MAN pushbutton, generates a preselected number (1 to 1999) of output cycles.

5 Control mode select pushbutton and associated LED's. Repetitive operation steps through the modes in the same sequence as the LED column. The modes are as follows:

FM— Frequency modulation mode. The 8116A's output can be frequency modulated by applying a voltage to the frontpanel CTRL INPUT connector.

AM— Amplitude modulation mode. The 8116A's output can be amplitude modulated by applying a voltage to the frontpanel CTRL INPUT connector.

PWM— Pulse width modulation mode. (Only applicable in pulse mode). The width of the 8116A's output pulse can be controlled by a signal applied to the front panel CTRL INPUT connector.

VCO— Voltage-controlled oscillator mode. In this mode, a signal applied to the CTRL INPUT connector determines the 8116A output frequency.

6 Phase pushbutton. By TRIG, GATE and optional BURST modes, the start phase is —90o in sine or triangle generation using this pushbutton. Haversine and havertriangle waveforms can thus be generated.

7 LINE switch. Power on/off pushbutton.

8 Trigger slope pushbuttons. In external triggering modes, the trigger slope of the signal applied to the EXT INPUT connector is selected using these pushbuttons. The currently selected slope is indicated by an illuminated pushbutton LED.

9 EXT INPUT connector. BNC connector for external trigger signals.

10 LEVEL adjust. Enables the external input trigger level to be adjusted from —10 V to +10 V.

11 MAN pushbutton. Used to simulate an external trigger signal. In optional sweep modes, it starts a single sweep cycle and resets from stop frequency to start frequency.

12 Single cycle pushbutton. (Opt. 001). Pressing this pushbutton generates a single output period in TRIG, GATE and E.BURST modes.

13 CTRL INPUT connector. BNC connector for external control signals.

Figure 3—1. Controls and Indicators (Option 001 included)

SECTION III
OPERATING AND PROGRAMMING

3–1 INTRODUCTION

3–2 The following operating information explains the functions of the controls and indicators of the Model 8116A Pulse/Function Generator. Front and rear panel controls, indicators and connectors are identified and briefly described in Figure 3–1, which should be read before continuing with the following description. Programming information is given at the end of this section.

3–3 SPECIAL OPERATING CONSIDERATIONS

3–4 Read the following four notes before applying power to the Model 8116A.

1. Read the Safety Summary at the beginning of this manual.

⚠ 2. Ensure the power selector switches are set properly for the power source being used to avoid instrument damage. This can be done by checking the line selection label on the rear panel.

CAUTION: Do not change the LINE SELECT switch setting with the instrument on or with power connected to the rear panel.

3. Ensure that load cannot be overdrive by the 8116A output (16 Vpp into 50 Ω; 32 Vpp into high impedance).

4. Do not apply an external voltage to the output connectors.

3–5 OPERATOR'S CHECKS

3–6 The 8116A performs a 'self check' at power switch-on. During this check, all LED's should be momentarily lit. In the event of a fault, an error code appears in the 8116A frontpanel digital display. The error codes are as follows:

⊏⊐ –	Indicates that a frontpanel key is jammed in the despressed position.
E11–	Indicates a fault by Auto Vernier/ External Sweep Trigger
E21–	Indicates a fault in the internal rep. rate generator
E31–	Indicates a fault in the internal width circuits. The width setting in pulse mode and the 'time between bursts' in I.BUR mode are affected.
E41/42–	Indicates an output amplifier fault.
E51-E62	Error indications for dedicated service tests.

3–7 OPERATING INSTRUCTIONS

3–8 Operating modes and parameters can be set on the frontpanel (local operation) or programmed using the HP-IB. The current operating mode is indicated by an illuminated LED in the MODE column on the frontpanel. Parameter selection for the 8116A digital display is indicated by an illuminated pushbutton LED. Similarly, current output waveform is also indicated by an illuminated pushbutton LED.

3–9 At power switch-on, the 8116A performs a self-test and automatically assumes the operating state prevailing at switch-off with the output disabled (DISABLE key LED lit) to protect externally connected devices. The operator should then select the required mode (NORM, TRIG, GATE, E.WID or an Opt. 001 mode when available) and output waveform. Upon selection, the 8116A automatically displays the parameters (mnemonically e.g. FRQ, DTY, AMP, OFS) which can be set within this mode. Parameter keys other than those which select the displayed parameters are not operational.

3–10 Pressing a parameter key then calls the current value of that parameter into the 8116A digital display, and a new value can be set using the RANGE and VERNIER keys. When all parameters are set to the required values, the DISABLE key should then be pressed to enable the output (key LED no longer illuminated).

3–11 In addition to the operating modes, the 8116A offers 4 control modes for modulating or controlling the output signal i.e. FM, AM, PWM, VCO. Table 3–1 shows which control mode can be combined with which operating mode. In the event of the operator selecting an erroneous combination e.g. E.WID and FM, the 8116A automatically displays ERROR and the E.WID and FM LED's will flash. Similarly, in NORM mode, when the operator makes incompatible timing settings (e.g. width greater than frequency) the 8116A displays ERROR.

Table 3–1. Operating/Control Mode Combinations

Mode / Modulate	NORM	TRIG	GATE	E.WID	I.SWP	E.SWP	I.BUR	E.BUR
FM	•	•	•	–	•	•	•(2)	•
AM	•	•	•	•(1)	•	•	•(2)	•
PWM	•(1)	•(1)	•(1)	–	•(1)	•(1)	–	•(1)
VCO	•	•	•	–	–	–	•	•

• = All waveforms
•(1) = Pulse waveform only
•(2) = All waveforms except pulse
– = Error combination

3–12 PARAMETERS

3–13 Figure 3–2 (Timing) and Figure 3–3 (Output Levels) illustrate the output signal parameters of the standard 8116A. A description of the various parameter-setting controls is given in Figure 3–1.

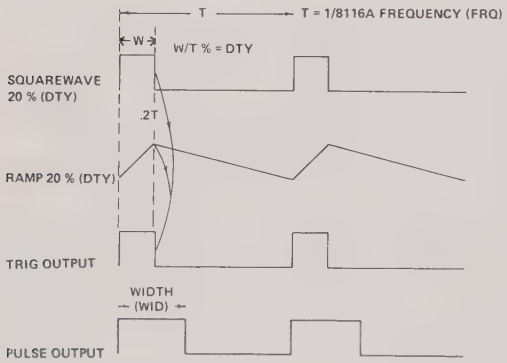


Figure 3–2. Timing Parameters

Figure 3–3. Output Level Parameters

3–14 As described in Figure 3–1, the parameter selection of the amplitude/offset keys is user-dependent. With any change to the HIL or LOL settings, the 8116A automatically calculates and stores the new amplitude and offset values.

3–15 Option 001 mode parameters are explained and illustrated under the respective mode description.

3–16 VERNIER / RANGE OPERATION

3–17 The vernier comprises 3 rocker-switches corresponding to the 3 display digits. Incrementing/decrementing a display digit is accomplished by pressing the upper/lower switch section respectively. (Continuous pressing causes continuous increment/decrement of the related display digit).

3–18 The RANGE key is also a rocker-switch for multiplying/dividing the displayed value by factor 10. For the offset parameter, pressing the key twice provides a quick means of setting 0 V.

3–19 AUTO VERNIER OPERATION

3–20 In NORM mode only, all parameters can be automatically incremented/decremented with selectable resolution. To activate AUTO VERNIER operation, first select the parameter to be incremented/decremented, then press the AUTO key. AUTO VERNIER can now be started by pressing any of the VERNIER keys.

3–21 There are 3 conditions, any of which causes an AUTO VERNIER 'wait' state i.e. AUTO VERNIER active (key LED lit), but no increment/decrement takes place. The conditions are:

1. timing error exists
2. at instrument specification limits e.g. frequency 50 MHz
3. at output level limits set via the LIMIT key.

AUTO VERNIER switch-off is accomplished by any of the following:

1. external signal to the EXT INPUT connector
2. pressing any key other than the vernier keys
3. pressing the AUTO key.

3–22 LIMIT OPERATION

3–23 Maximum high (HIL) and low (LOL) levels into 50 Ohm can be set to protect the device under test. Pushing the LIMIT key sets the currently active high and low levels as the 8116A output limits – which cannot be exceeded as long as LIMIT operation is active (key LED lit).

3–24 EXTERNAL TRIGGERING

3–25 Five pushbuttons, a trigger level adjust and BNC connector (EXT INPUT) facilitate external triggering of the 8116A. The function of the individual pushbuttons in the various external triggering modes is described in the following.

3–26 –90°

3–27 With TRIG, GATE or E.BUR (Opt. 001) mode selected, and output waveform set to sine or triangle, pressing this pushbutton shifts the start phase to –90°. As a result, haversine and havertriangle signals can be generated by the 8116A.

3–28 Trigger Slopes

3–29 Positive or negative slope is selectable for triggering on the signal applied to the EXT INPUT connector. With no slope selected (both key LED's off), the EXT INPUT is switched off.

3–30 Triggering level on the selected slope is set via the LEVEL adjust.

3–31 Note that in E.SWP mode (Opt. 001), two trigger pulses may be required. If the 8116A is not set to the start frequency (STA) i.e. STA key LED not illuminated, the first trigger pulse sets the 8116A to the STA frequency. The second trigger pulse then starts the sweep.

3–32 MAN

3–33 In external trigger modes, the 8116A can be triggered manually via the MAN pushbutton:

TRIG Mode. Each operation of the MAN key generates one output cycle, cycle time being determined by the 8116A frequency setting.

GATE Mode. The 8116A outputs continuously for as long as the MAN key is depressed. Frequency is determined by the 8116A frequency setting.

E.SWP Mode (Opt. 001). MAN key operation starts the sweep only if the 8116A is set to the start frequency (STA) i.e. STA key LED illuminated. Otherwise, MAN key must be pressed twice; the first time to reset the 8116A to STA, the second to start the sweep.

E.BUR Mode (Opt. 001). Each operation of the MAN key triggers a burst output.

3–34 1 CYCLE (OPTION 001)

3–35 In TRIG, GATE and E.BUR modes, each operation of this key generates a single cycle at the 8116A output.

3–36 CONTROL MODES

3–37 The 8116A output signal can be modulated (AM, FM, PWM) or controlled (VCO) by applying a signal to the CTRL INPUT connector. Table 3–1 indicates the permitted operating mode/control mode combination, a brief description of each control mode being given in the following. For specification details in each mode – see Table 1–2.

3–38 FM

3–39 The 8116A's output can be frequency modulated by applying a signal to the CTRL INPUT connector.

3–40 AM

3–41 The 8116A's output can be amplitude modulated by applying a signal to the CTRL INPUT connector. A ground symmetrical modulating signal provides a modulation of 0–100 %. 200 % modulation (DSBSC) can also be obtained. Figure 3–4 illustrates 100 % modulation and DSBSC.

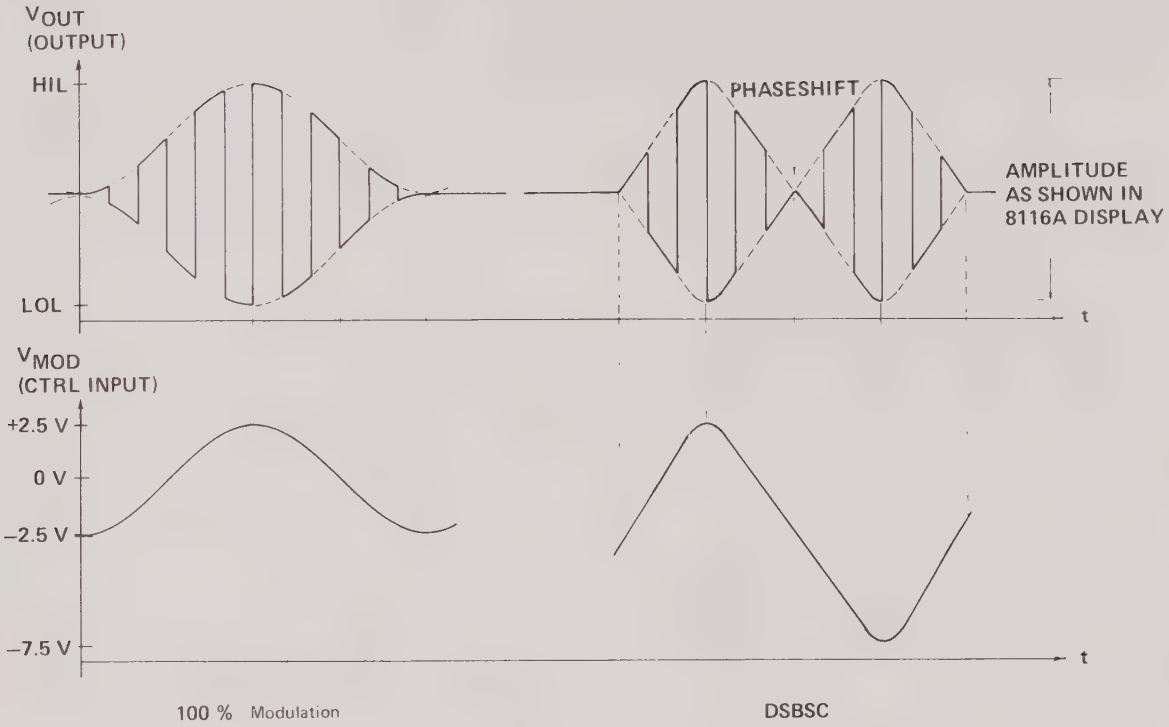


Figure 3–4. Amplitude Modulation

3–42 PWM

3–43 In pulse mode, the 8116A's output can be pulse width modulated by applying a signal to the CTRL INPUT connector. Pulse width modulation is available in any one of 8 non-overlapping decade ranges, as illustrated in Figure 3–5.

3–44 VCO

3–45 In this mode, a signal applied to the CTRL INPUT connector determines the output frequency. Output frequency range is a maximum 1:100 as shown in Figure 3–6.
Range selection is automatically determined by the 8116A frequency (FRQ) setting, the selected range being that whose upper decade brackets the FRQ setting. Figure 3–6 gives a range selection example for an FRQ setting of 500 Hz.

3–47 OPERATING MODES

3–48 Each of the 8 operating modes (standard and Opt. 001) is described briefly in Figure 3–7 to 3–12. For each mode, a short procedure is given to aid quick mode entry together with timing diagrams to illustrate the various outputs in the described mode.

3–49 The 8116A illustration located in each figure highlights the parameter mnemonics, hence parameter settings, associated with the presented mode.

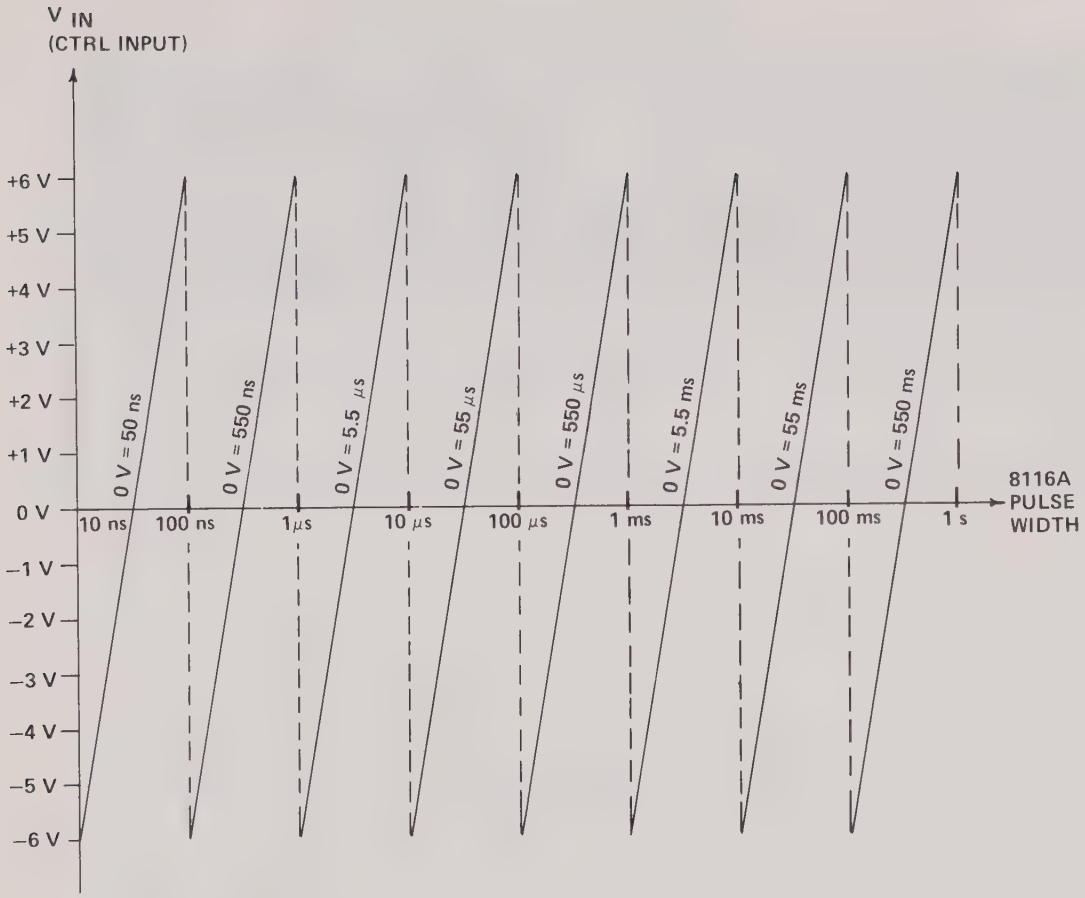


Figure 3–5. PWM Characteristics

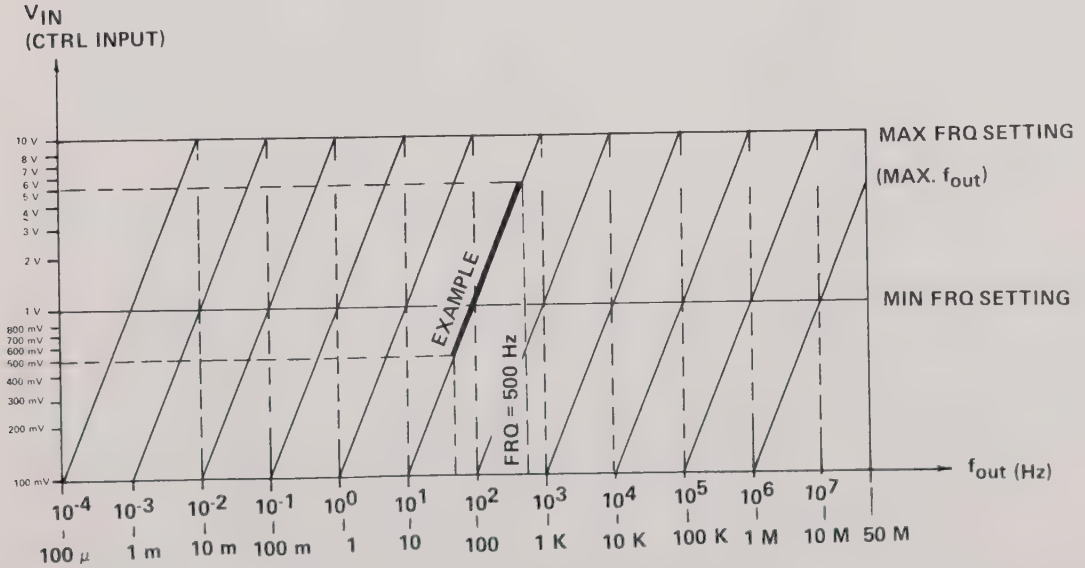
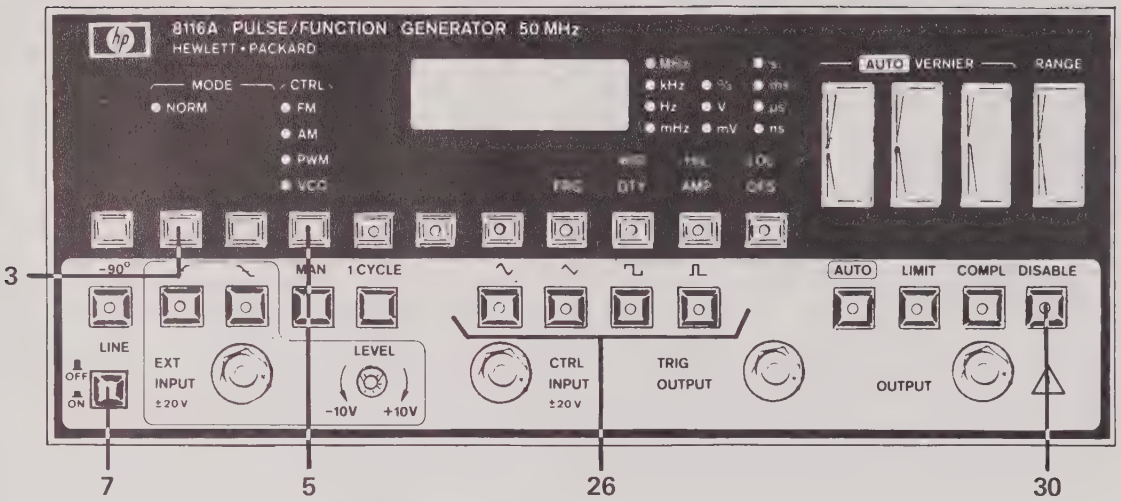


Figure 3–6. VCO Characteristics

Figure 3–7. **NORM MODE**



NOTE: For parameter specifications, see Table 1–2.

1. Set the LINE switch (7) to the ON position.

2. Select NORM mode (if necessary) via key (3). Standard modes are stepped-through by repetitive operation of this key.

3. Select the desired waveform at row (26). The parameter menu will automatically be illuminated as shown above (WID only illuminated if pulse waveform selected; also, although HIL, LOL, AMP and OFS can all be selected, only HIL/LOL or AMP/OFS will be illuminated at any one point in time – see Figure 3–1 description).

4. Select each parameter, in turn, via its associated key, and set it to the desired value using the RANGE/ VERNIER keys and the digital display.

5. If a modulated output is required, select the desired modulation via key (5), and apply the modulating signal to the CTRL INPUT connector.

6. Press key (30) to enable the 8116A output. Key LED should no longer be illuminated. The following timing diagram illustrates the outputs in NORM mode.

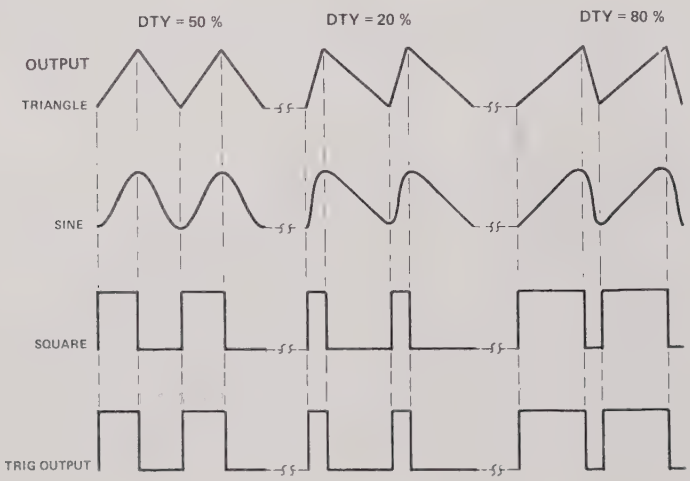
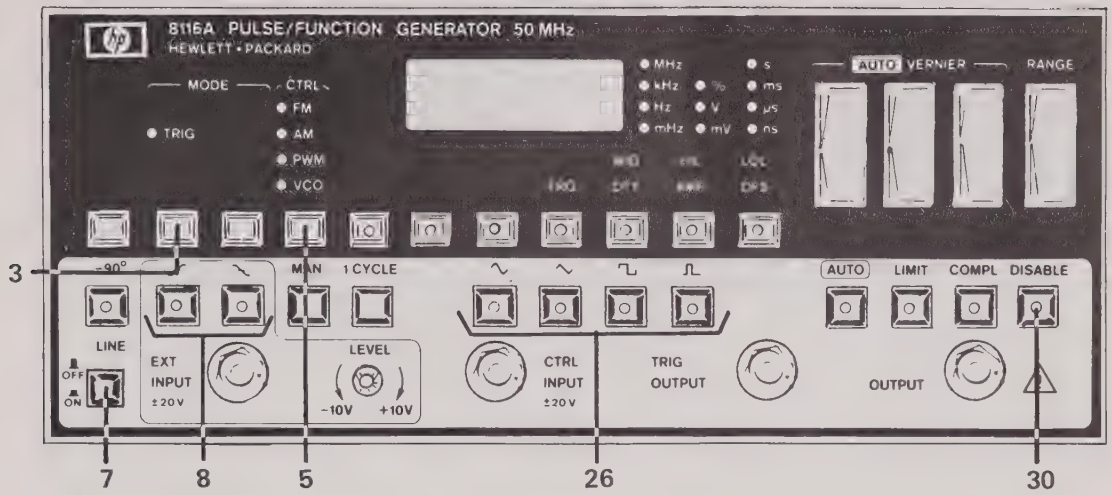


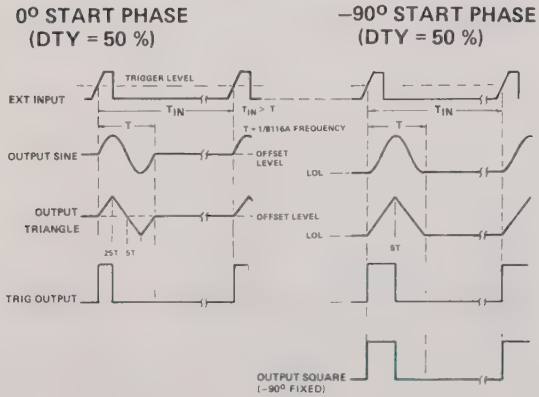
Figure 3–8. **TRIG MODE**



NOTE: For parameter specifications, see Table 1–2.

1. Set the LINE switch (7) to the ON position.
2. Select TRIG mode via key (3). Standard modes are stepped-through by repetitive operation of this key.
3. Select the desired waveform at row (26). The parameter menu will automatically be illuminated, this being a combination of those shown above, e.g. WID only illuminated if pulse waveform selected.
4. Select each parameter, in turn, via its associated key, and set it to the desired value using the RANGE/ VERNIER keys and the digital display. Note that the frequency setting should be set less than the frequency of the trigger signal.
5. If triggering is by an external signal, select the trigger slope at (8), and apply the trigger signal to the EXT INPUT connector. Triggering can also be simulated by press the MAN key.
6. If a modulated output is required, select the desired modulation via key (5), and apply the modulating signal to the CTRL INPUT connector.
7. Press key (30) to enable the 8116A output. This key LED should no longer be illuminated. The following timing diagrams illustrate some outputs in TRIG mode.

FUNCTIONS



PULSE

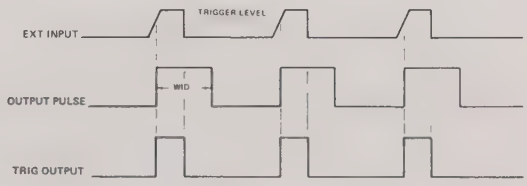
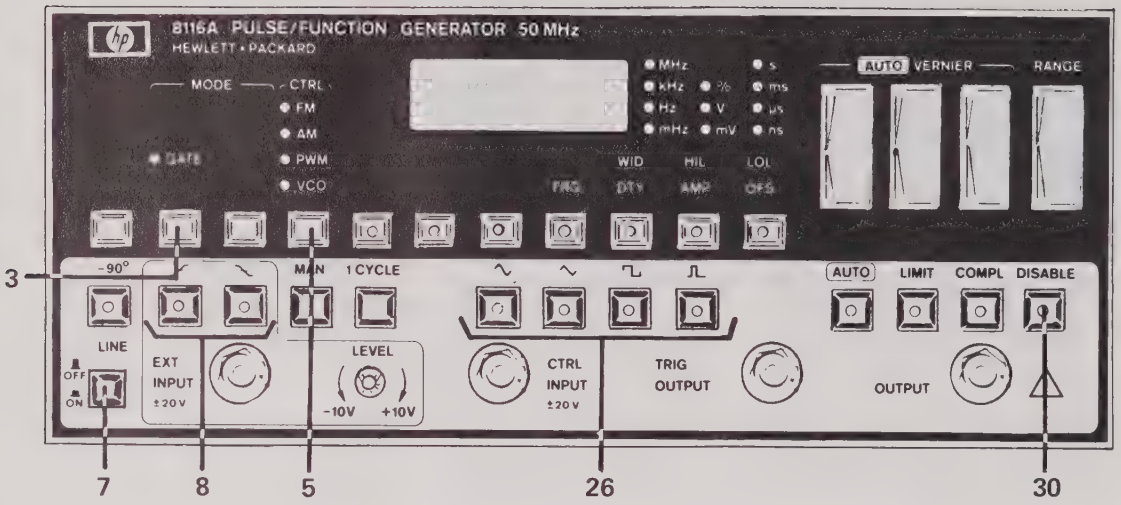


Figure 3–9. **GATE MODE**



NOTE: For parameter specifications, see Table 1–2.

1. Set the LINE switch (7) to the ON position.
2. Select GATE mode via key (3). Standard modes are stepped — through by repetitive operation of this key.
3. Select the desired waveform at row (26). The parameter menu will automatically be illuminated, this being a combination of those shown above e.g. WID only illuminated if pulse waveform selected.
4. Select each parameter, in turn, and set it to the desired value using the RANGE/VERNIER keys and the digital display.
5. If gating by an external signal, select the trigger slope at (8), and apply the gate signal to the EXT INPUT connector.
6. If a modulated output is required, select the desired modulation via key (5), and apply the modulating signal to the CTRL INPUT connector.
7. Press key (30) to enable the 8116A output. This key LED should no longer be illuminated. The following timing diagrams illustrate some outputs in Gate mode.

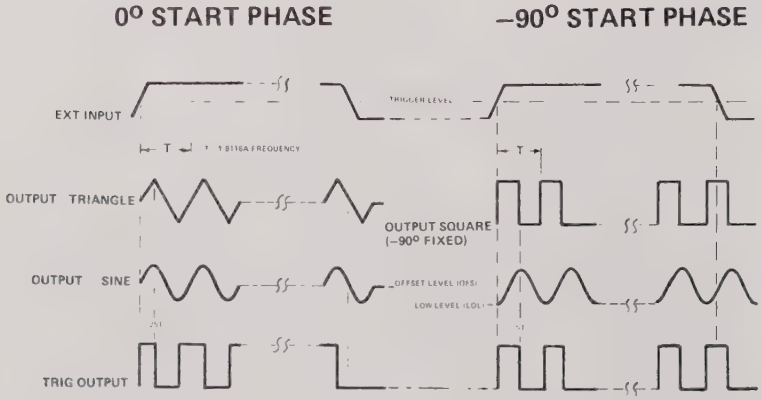
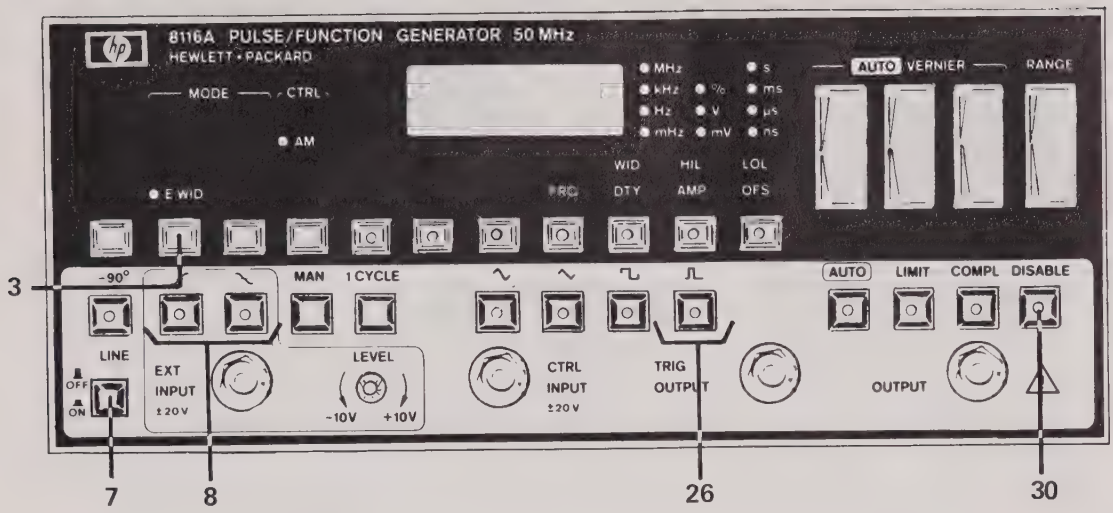


Figure 3–10. **E.WID MODE**



NOTE: For parameter specifications, see Table 1–2.

1. Set the LINE switch (7) to the ON position.
2. Select E.WID mode via key (3). Standard modes are stepped — through by repetitive operation of this key.
3. Select pulse waveform at row (26). The parameter menu will automatically be illuminated, i.e. AMP/OFS or HIL/LOL — see Figure 3–1 description of these parameter keys.
4. Select each parameter in turn, and set it to the desired value using the RANGE/VERNIER keys and the digital display.
5. Apply the external signal to be shaped to the EXT INPUT connector and select the trigger slope at (8)
6. Press key (30) to enable the 8116A output. This key LED should no longer be illuminated. A timing diagram illustrating an output in this mode is given in the following.

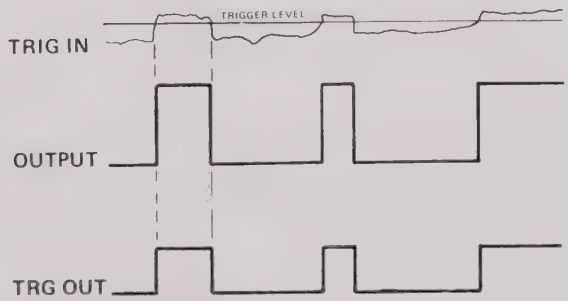
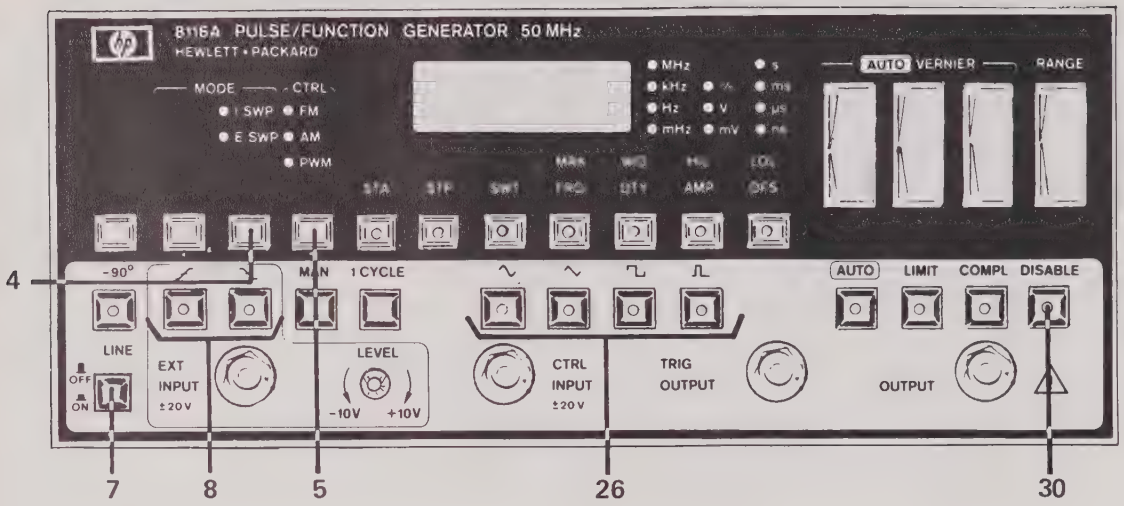


Figure 3–11. **SWEEP MODES**



NOTE: For parameter specifications, see Table 1–2.

1. Set the LINE switch (7) to the ON position.

2. Select a sweep mode (Internal or External) via key (4). Repetitive operation of this key steps through the Opt. 001 modes.

3. Select the desired waveform at row (26). The parameter menu will be automatically illuminated in mnemonic form, e.g. AMP for amplitude. The sweep-related parameters (STA, STP, SWT, MRK) are illustrated in the following timing diagrams.

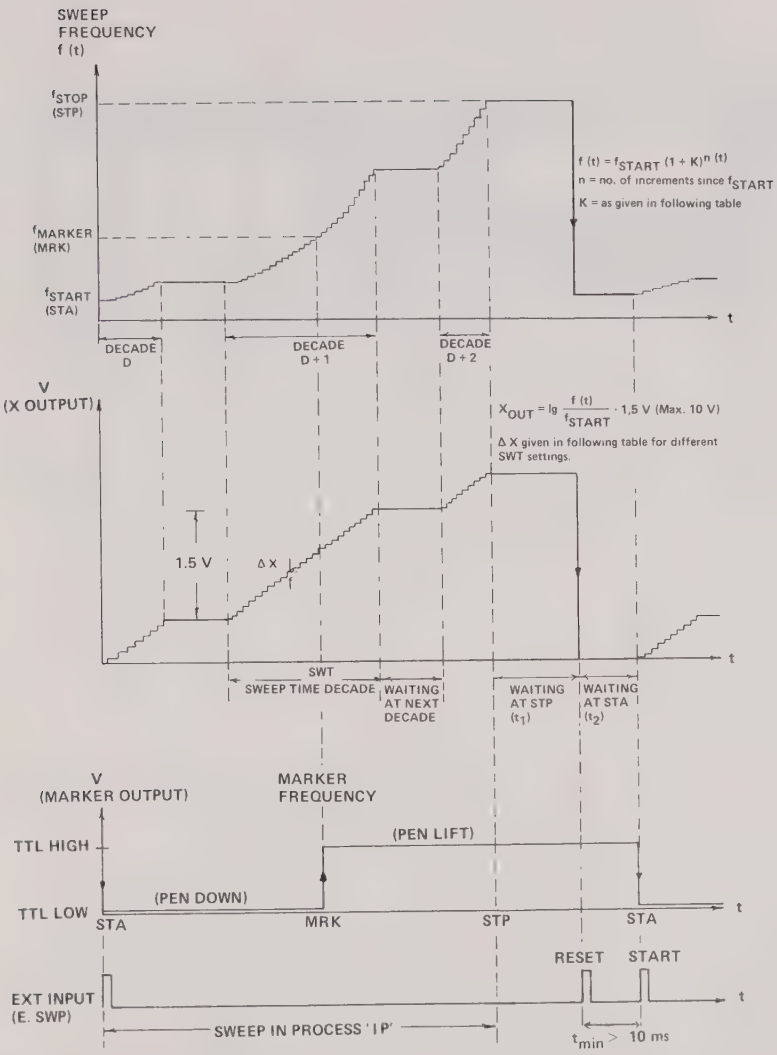
4. Select each parameter, in turn, and set it to the required value using the RANGE/VERNIER keys and the digital display.

5. If triggering via an external signal (E. SWP), select the trigger slope at (8), and apply the trigger signal to the EXT INPUT connector. Triggering can also be simulated by pressing the MAN key. In either case, note the trigger requirements i.e. a 'reset' pulse is required prior to the 'start' pulse if the 8116A is not currently set to the STA frequency.

6. If a modulated output is required, select modulation via key (5) and apply the modulating signal to the CTRL INPUT connector.

7. Press key (30) to enable the 8116A output. The key LED should no longer be illuminated. The following timing diagrams illustrate the 8116A outputs in sweep modes.

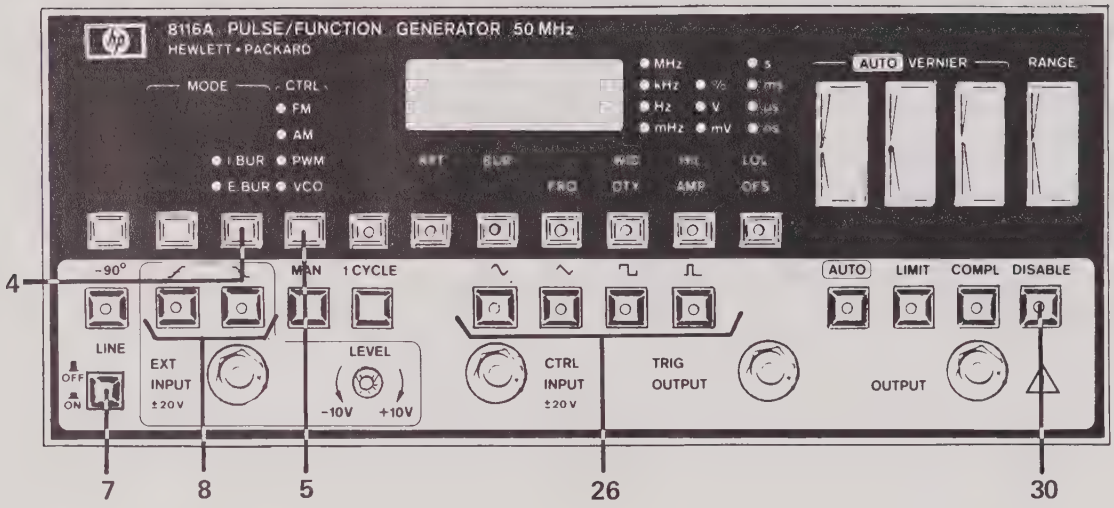
NOTES:
1. When external sweep is in process ('IP' in display), RANGE/VERNIER keys are disable (also disabled during period 't_4' in following timing diagrams).
2. Sweep (I. SWP and E. SWP) can be interrupted by pressing any key other than RANGE/VERNIER/MAN/I CYCLE keys.



SWT (Sweeptime/ Decade)	K Factor	η DEC (increments/ decade)	Δ X (X_{OUT} / increment)
10 ms	0.0625	38	40 mV
20 ms	0.03125	75	20 mV
50 ms	0.015625	149	10 mV
100 ms	0.015625	149	10 mV
200 ms	0.015625	149	10 mV
500 ms	0.015625	149	10 mV
1 s	0.015625	149	10 mV
2 s	0.015625	149	10 mV
5 s	0.015625	149	10 mV
10 s	0.015625	149	10 mV
20 s	0.015625	149	10 mV
50 s	0.015625	149	10 mV
100 s	0.015625	149	10 mV
200 s	0.015625	149	10 mV
500 s	0.015625	149	10 mV

SWT is set in multiples of 1, 2 or 5 via the VERNIER keys, or in decades by the RANGE key.

Figure 3–12. **BURST MODES**



NOTE: For parameter specifications, see Table 1–2.

1. Set the LINE switch (7) to the ON position.

2. Select a burst mode (Internal or External) via key (4). Repetitive operation of this key steps through the Opt. 001 modes.

3. Select the desired waveform at row (26) (Pulse mode not available with I. BUR). The parameter menu will automatically be displayed in mnemonic form. The burst-related parameters (RPT, BUR) are defined in the following timing diagrams.

4. Select each parameter in turn, and set it to the required value using the RANGE/VERNIER keys and the digital display.

5. If triggering via an external signal (E.BUR), select the trigger slope at (8), and apply the trigger signal to the EXT INPUT connector.

6. If a modulated output is required, select modulation via key (5), and apply the modulating signal to the CTRL INPUT connector. See Table 3–1 for burst/control mode combinations.

7. Press key (30) to enable the 8116A output. The key LED should no longer be illuminated. The following timing diagrams illustrate the 8116A output in burst modes.

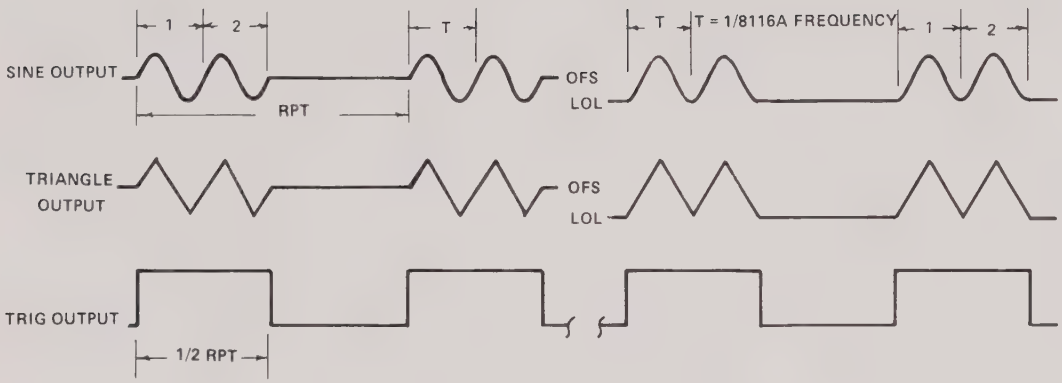
I. BUR

0° START PHASE

(BUR = 2; DTY = 50 %)

–90° START PHASE

(BUR = 2; DTY = 50 %)



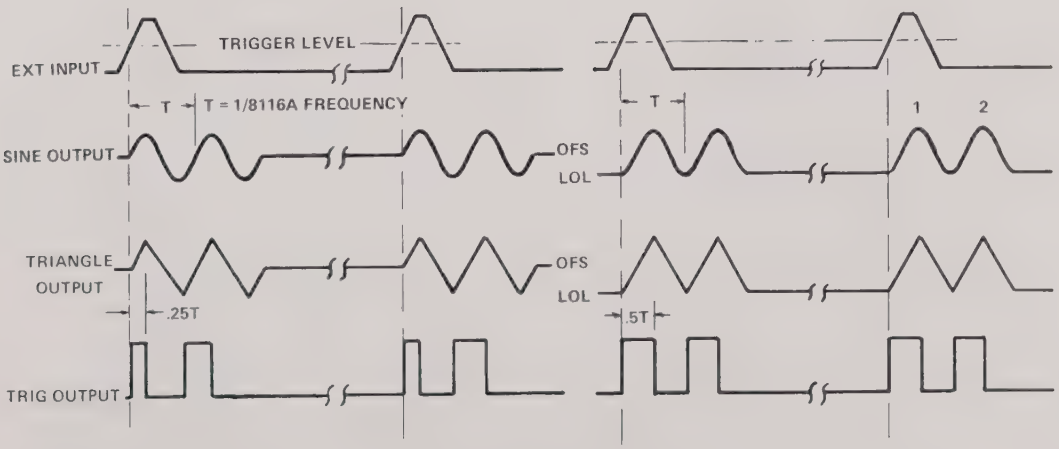
E. BUR

0° START PHASE

(BUR = 2; DTY = 50 %)

–90° START PHASE

(BUR = 2; DTY = 50 %)



3–50 PROGRAMMING

3–51 General

3–52 The 8116A operates on the HP-IB as follows:

Listens: to messages from the HP-IB system controller. In this state, all modes and parameters, except external trigger LEVEL adjust, are programmable. Also provided are special HP-IB only functions to aid the programmer.

Talks: provides error messages and reports operating parameters.

3–53 As shown in Figure 3–13, the bus lines are as follows (all use negative logic):

8-bit data bus (lines DIO 1 to 8)

handshake lines – DAV (data valid), NRFD (not ready for data), NDAC (data not accepted).

control lines – IFC (interface clear), ATN (attention), SRQ (service request), REN (remote enable), EOI (end or identify).

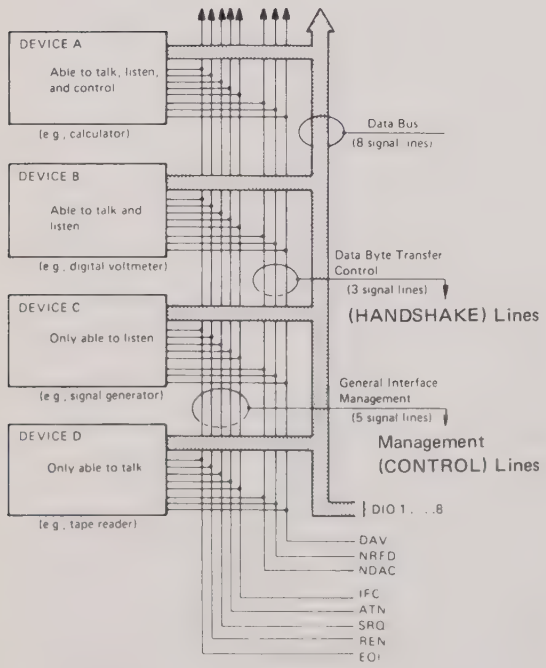


Figure 3–13. Interface Connections + Bus Structure

The 8116A uses all lines on the bus, terminations, logic levels and pinouts being described in Section II. In this manual, bus information will generally be restricted to 8116A specifics. For this reason, handshake lines are not discussed, and control lines are only mentioned in connection with specific 8116A activity. Permissible codes are presented in Table 3–9. For detailed bus information, refer to any of the following publications:

IEEE	Interface Standard 488–1975
ANSI	Interface Standard MC1.1.
HP	Publication 59401–90030
HP	Publication 5952–0058

3–54 Address Assignment

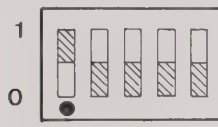
3–55 The 8116A's HP-IB address is determined by an internal storage register. This register is inialized upon power turn-on by reading the address bits A1 through A5 from the HP-IB ADDRESS switch on the rear panel. Note that this switch is factory preset to decimal 16. To change the address, first change the bit settings on the rear panel switch, then press the LCL key to read the new address into the register (alternatively, switch power off and on). Table 3–2 lists all the possible addresses on the bus.

3–56 The current HP-IB address can be checked by pressing the LCL key. The address is then displayed in decimal form.

3–57 Talk and listen addresses are transmitted by the system controller over the data bus with the ATN line true. When an instrument recognizes its address, it will respond accordingly i.e. listen if listen address has been transmitted; talk if talk address has been transmitted. When allocating addresses, make sure no two instruments have the same address. To program an address, set ATN true and arrange that the ASCII character derived from Table 3–2 appears on the bus. For deaddressing, use UNL, UNT commands (or address another device).

Table 3–2. Available Addresses (ATN true)

Data bus (DIO lines)		Address in ASCII		
Fixed 8 7 6	Selectable 5 4 3 2 1	Talk	Listen	
0 T L	0 0 0 0 0	@	Space	
0 T L	0 0 0 0 1	A	!	
0 T L	0 0 0 1 0	B	"	
0 T L	0 0 0 1 1	C	#	
0 T L	0 0 1 0 0	D	$	
0 T L	0 0 1 0 1	E	%	
0 T L	0 0 1 1 0	F	&	
0 T L	0 0 1 1 1	G	'	
0 T L	0 1 0 0 0	H	(	
0 T L	0 1 0 0 1	I	)	
0 T L	0 1 0 1 0	J	*	
0 T L	0 1 0 1 1	K	+	
0 T L	0 1 1 0 0	L	,	
0 T L	0 1 1 0 1	M	–	
0 T L	0 1 1 1 0	N	.	
0 T L	0 1 1 1 1	O	/	
0 T L	1 0 0 0 0	P	0	← 8116A set to this address at factory.
0 T L	1 0 0 0 1	Q	1	
0 T L	1 0 0 1 0	R	2	
0 T L	1 0 0 1 1	S	3	
0 T L	1 0 1 0 0	T	4	
0 T L	1 0 1 0 1	U	5	← Usually controller address!
0 T L	1 0 1 1 0	V	6	
0 T L	1 0 1 1 1	W	7	
0 T L	1 1 0 0 0	X	8	
0 T L	1 1 0 0 1	Y	9	
0 T L	1 1 0 1 0	Z	:	
0 T L	1 1 0 1 1	[	;	
0 T L	1 1 1 0 0	\	<	
0 T L	1 1 1 0 1	]	=	
0 T L	1 1 1 1 0	^	>	
0 T L	1 1 1 1 1	_	?	← Forbidden setting! UNT, UNL commands.



Selector on 8116A rear panel (factory setting).

L = 1 for listen address, 0 for talk address
T = 1 for talk address, 0 for listen address

3–58 Remote Operator's Checks

3–59 A quick check of the 8116A's talk/listen functions is provided in Figure 3–14. [Program example assumes the 8116A address is set to the factory value 16].

3–60 Also implemented in the 8116A is a RAM/hardware self-test routine initialized via HP-IB message 'EST' – see Figure 3–15. Tested hardware functions include:

Repetition rate generator
Width generator
Shaper/output amplifier
Auto vernier

3–61 In the event of fault detection, the 8116A sets bits 4 and 7 (System Failure and Service Request) of its HP-IB Status Byte to '1'. More information on this status byte is given later under 'Error Reporting'.

Figure 3–14. **TALK/LISTEN FUNCTION CHECK**

Flowchart	HPL Statements (HP 9826 Desktop Computer)	BASIC Statements (HP 85 Desktop Computer)	Visual Indicators
START			
Set REN line true to ensure 8116A is in remote enable state	rem 716	REMOTE 716	RMT LED on
Program 8116A frequency to 1 Hz	wrt 716, "FRQ 1 Hz"	OUTPUT 716; "FRQ 1 Hz"	RMT and ADS LED's on. FRQ key LED on. '1.00 Hz' displayed.
Interrogate 8116A frequency setting	wrt 716, "IFRQ" dim A$ [12] red 716, A$	OUTPUT 716; "IFRQ" ENTER 716; A$	
Print 8116A frequency	prt A$	PRINT A$	Printout "FRQ 1.00 Hz"
END			

Figure 3–15. **RAM / HARDWARE CHECK**

Flowchart	HPL Statement (HP 9826)	BASIC Statement (HP 85)
START		
Set REN line true to ensure 8116A is in remote enable state	rem 716	REMOTE 716
Program 8116A to execute self-test	wrt 716, "EST"	OUTPUT 716; "EST"
Read status of 8116A HP-IB Status Register, and store decimal value of status byte in A	red 716, A	ENTER 716; A
A = 0 (no / yes)		
Print "8116A FAULT"	if A=0; prt "8116A FAULT"	IF A=0 THEN PRINT "8116A FAULT"
END		

3–62 Mode and Parameter Settings (Listener Function)

3–63 When the 8116A is in remote and has been listen addressed, it accepts messages which change parameter and/or mode settings. Each mode and parameter-setting message comprises either a number of ASCII data bytes transmitted serially over the data lines with ATN false or an HP-IB Universal Command. The coding for the bytes is given in Table 3–3, which summarizes all mode/parameter-setting messages. Note: The HP-IB program code syntax for parameters is identical to the front panel mnemonics e.g. AMP for amplitude. Reference may be made to Table 3–9 to convert each ASCII byte to a bit pattern on the data bus.

3–64 The 8116A responds to program codes in the Data message in the order in which they are received. When programming, therefore, ensure that the first parameter setting in the string is compatible with the current settings.

e.g. Current Settings: HIL = 2 V
LOL = 0 V

Program settings: HIL = 4 V
LOL = 2.5 V

In the example, the new HIL setting should appear first in the string. If LOL is programmed first, the new value (2.5 V) is not compatible with the current HIL setting (2 V) and therefore not accepted, a 'service request' then being sent to the controller. More information on parameter programming sequence is given under 'Error Reporting'.

3–65 End of String Message (EOS). This can be the ASCII character sequence CR, LF (decimal 13, 10) or the bus END command (EOI and ATN true).

3–66 Mode and Parameter Settings (Talker Function)

3–67 The 8116A can send data messages, concerning its mode/parameter settings, when in remote and addressed to talk. The available output modes are:

Learn String
Interrogate Function
Status

Table 3–4 lists the ASCII commands associated with each of these modes.

3–68 The Learn String consists of a 153 character ASCII string representing the 8116A current settings. The Interrogate Function sends a data message consisting of a 14 character ASCII string representing the current setting of the interrogated parameter.

3–69 The Status Function sends an 8-bit byte in response to a Serial Poll. Bits 5 and 6 of bits 1 through 8 are allocated for current operating conditions:

Bit 5 set to one (16 dec) indicates "Autovernier in Progress"

Bit 6 set one (32 dec) indicates "Sweep in Progress"

A more detailed description of the Status Byte is given under 'Error Reporting'.

3–70 In all talker modes, the 8116A terminates its data message with the ASCII character sequence CR/LF.

Table 3–3. Mode / Parameter Messages (listen function)

MESSAGE	MNEMONICS ASCII CODE	ASCII CODE DELIMITERS	SAMPLE STATEMENTS
Operating Modes			
select NORM	M1		
select TRIG	M2		
select GATE	M3		
select E.WID	M4		
select I.SWP	M5		
select E.SWP	M6 (Opt. 001)		
select I.BUR	M7 (Opt. 001)		HPL (HP 9826) / BASIC (HP 85)
select E.BUR	M8 (Opt. 001)		
Control Modes			
off	CT0		
select FM	CT1		OUTPUT 716;
select AM	CT2		wrt 716, "M2, T1, W2" / "M2, T1, W2"
select PWM	CT3		selects trigger mode with triggering on the positive slope of external signal, and triangle output.
select VCO	CT4		
Trigger Slope			
off	T0		
select positive slope	T1		
select negative slope	T2		
Haversine (–90°)			
off	H0		
on	H1		
Waveform			
off (dc)	W0		
select sine	W1		
select triangle	W2		
select square	W3		
select pulse	W4		
Parameters			
set frequency	FRQ	MZ = Millihertz HZ = Hertz KHZ = Kilohertz MHZ = Megahertz	
set duty cycle	DTY	%	
set width	WID	NS = Nanoseconds US = Microseconds MS = Milliseconds	
set amplitude	AMP	MV = Millivolts V = Volts	
set offset	OFS	MV = Millivolts V = Volts	

Table 3–3. Mode / Parameter Messages (cont'd)

MESSAGE	MNEMONICS ASCII CODE	ASCII CODE DELIMITERS	SAMPLE STATEMENTS
set high level	HIL	V = Volts	**HPL** wrt 716, "FRQ 1 KHZ, DTY 50 %, BUR 7 #, RPT 100 US"
set low level	LOL	V = Volts	**BASIC** OUTPUT 716;"FRQ 1 KHZ, DTY 50 %, BUR 7 #, RPT 100 US"
			sets frequency to 1 kHz, duty cycle to 50 %, burst number to 7 and time between burst 'starts' to 100 μs
set burst number	BUR	#	
set repetition rate for internal burst	RPT	NS = Nanoseconds US = Microseconds MS = Milliseconds	
set sweep start frequency	STA	MZ = Millihertz HZ = Hertz KHZ = Kilohertz MHZ = Megahertz	
set sweep stop frequency	STP (Opt. 001)	MZ = Millihertz HZ = Hertz KHZ = Kilohertz MHZ = Megahertz	
set sweep marker frequency	MRK	MZ = Millihertz HZ = Hertz KHZ = Kilohertz MHZ = Megahertz	
set sweep time	SWT	S = Seconds MS = Milliseconds	
Sign			
+	+		
+	–		
Decimal point			
.	.		
Limit			
off	LO		
on	LI		
Complement			
off (normal output)	C0		
on	C1		

Table 3–3. Mode / Parameter Messages (cont'd)

MESSAGE	MNEMONICS ASCII CODE	ASCII CODE DELIMITERS	SAMPLE STATEMENTS
Disable			
off (output enabled)	D0		
on	D1		
Autovernier mode			
off	A0		
on	A1		
Autovernier start			HPL: wrt 716, "OFS 120 MV, A1, LU" — BASIC: OUTPUT 716; "OFS 120 MV, A1, LU"
most significant digit up	MU		offset is incremented in 1mV steps with offset start value 120 mV
second significant digit up	SU		
least significant digit up	LU		
most significant digit down	MD		
second significant digit down	SD		
least significant digit down	LD		
Range			
Up	RU		
Down	RD		
HP-IB Universal Commands			
Device Clear (DCL)	DC4	Loads standard parameter set stored in 8116A ROM's. 8116A does not remain in remote mode e.g. CLEAR 7	HPL: clr 7 — BASIC: CLEAR 7
Selected Device Clear (SDC)	EOT	Loads standard parameter set stored in 8116A ROM's. 8116A remains in remote mode.	HPL: clr 716 — BASIC: CLEAR 716
Group Execute Trigger (GET)	BS	When the 8116A is in trigger, external sweep mode, this message initiates a single cycle, burst or sweep respectively.	HPL: trg 716 — BASIC: TRIGGER 719

NOTES:
1. Lower case letters can replace any or all of the ASCII capitals.
2. When programming a parameter for which delimiters are given, the parameter string must be terminated with a delimiter e.g. wrt 716, "BUR 17 #".
↑

Table 3–4. Mode/Parameter Messages (Talker Function)

Message	ASCII Mnemonics	Sample Statements	
Current Parameter Setting	CST	HPL (HP 9826) dim A$ [153] wrt 716, "CST" red 716, A$	BASIC (HP 85) DIM A$ [153] OUTPUT 716; "CST" ENTER 716; A$
Interrogate Parameter	IFRQ IDTY IWID IHIL ILOL IAMP IOFS IBUR IRPT ISTA ISTP IMRK ISWT	dim B$ [14] wrt 716, "IFRQ" red 716, B$	DIM B$ [14] OUTPUT 716; "IFRQ" ENTER 716; B$
Status Byte (Serial Poll Enable/ Serial Poll Disable)	CAN EM	rds (716) → A	A = SPOLL (716)

3–71 Error Reporting

3–72 In general, whenever a program attempts to put the 8116A into an error condition, the 8116A responds by making a Service request i.e. set SRQ line true. Under these circumstances, the system controller will address the 8116A as talker using a serial poll command (SPE), the 8116A then responding by putting an error message on the data bus. This message consists of a single 8-bit byte in which SRQ bit 7 is set true ('1') and bits 1 to 3 comprise an error code. The contents of this byte are shown in Table 3–5.

3–73 As can be seen from Table 3–5, bits 1 to 3 are each allocated to an error type. i.e. TIMING, PROGRAMMING and SYNTAX. In each case the bit is set to '1' for error indication.

3–74 Should a more detailed description of the error be required (e.g. duty cycle error or width error when TIMING ERROR is indicated by the status byte), this can be done via the 'interrogate error' (IERR) command. Table 3–6 and 3–7 list the 8116A responses to the IERR command for TIMING and PROGRAMMING errors respectively.

3–75 Service Request. Bit 7 of the HP-IB Status Byte is usually set in conjunction with any of bits 1–4 (error indicators). However, in the case of the TIMING ERROR indication (bit 1), the 'Service Request' message can be suppressed via the command "SR 0"

e.g. (HPL) wrt 716, "SR 0"
(BASIC) OUTPUT 716; "SR0"

This is particularly useful for character strings where more than one timing parameter is programmed. The reason is best explained by an example:

e.g. Current Settings: FRQ 500 Hz
WID 1 ms
Program Settings: FRQ 1 kHz
WID 0.5 ms

Immediately upon receiving the new frequency value (first position in string), the 8116A would set SRQ true if SRQ is active, because the new value is not compatible with the current width setting. By suppressing SRQ, both new settings for frequency and width are accepted by the 8116A without any interruption to program flow by SRQ.

Note: In the permanently stored mode/parameter settings in the 8116A's ROM's, 'SR' is set to '0'. Should these settings be called up as current settings, the service request function can be re-activated for timing errors by programming 'SR' to '1'

e.g. (HPL) wrt 716, "SR1"
(BASIC) OUTPUT 716; "SR 1"

Table 3–5. HP-IB Status Byte

HP-IB Status Byte								Sample Statements	
								HPL (HP 9826)	BASIC (HP 85)
Bit 8 (DIO 8)	Bit 7 (DIO 7)	Bit 6 (DIO 6)	Bit 5 (DIO 5)	Bit 4 (DIO 4)	Bit 3 (DIO 3)	Bit 2 (DIO 2)	Bit 1 (DIO 1)	rds (716) → A	A = SPOLL (716)

Bit 1 (DIO 1): "1" = TIMING ERROR (Causes SRQ)

Bit 2 (DIO 2): "1" = PROGRAMMING ERROR (Causes SRQ)

Bit 3 (DIO 3): "1" = SYNTAX ERROR (Causes SRQ)

Bit 4 (DIO 4): Allocated for error detection during self-test routine – see para 3–60. "1" = SYSTEM FAILURE (Causes SRQ)

Bit 5 (DIO 5): "1" = AUTOVERNIER IN PROCESS (no SRQ)

Bit 6 (DIO 6): "1" = SWEEP IN PROCESS (no SRQ)

Bit 7 (DIO 7): "1" = SERVICE REQUEST

Bit 8 (DIO 8): NOT USED

e.g. 0 1 0 0 0 1 0 0 (68 decimal) indicates SYNTAX ERROR

Table 3–6. Timing Error Messages (Response to interrogate error statement 'IERR')

ASCII String	Comments
WAVEFORM ERROR (15 characters)	1. This message is sent when any of the following conditions are not observed: a) In PWM control mode, pulse waveform must be selected. b) In E.WID mode, pulse waveform must be selected. c) With E.WID mode and pulse waveform selected, the only permissible control mode is AM. d) In I.BUR mode, pulse waveform is not allowed. Table 3–1 provides a complete overview of permissible mode/waveform combinations. 2. The 8116A output remains unchanged during the error condition, and front panel LED's blink to indicate the erroneous settings. 3. SRQ cannot be suppressed for this error (see 'Service Request' description).
DUTY C. ERROR (14 characters)	1. This message is sent to indicate 'duty cycle error' when either of the following conditions are not observed: a) In frequency range 1 MHz to 9.99 MHz, duty cycle limits are 20 % to 80 %. b) For frequencies ⩾ 10 MHz, duty cycle must be set to 50 %. 2. The erroneous duty cycle setting is not stored in the 8116A memory, and the output remains unchanged. 3. SRQ cannot be suppressed for this error – see 'Service Request' description.

Table 3–6. Timing Error Messages (cont'd)

WIDTH ERROR (12 characters)	1. This message is sent when the width and frequency settings are incompatible. 2. 8116A hardware detects this error condition which causes the output to change. 3. SRQ can be suppressed for this error via the HP-IB message "SR0". In this case, the first bit of the HP-IB status byte is still set to '1' during error condition. "SR0" is the 8116A's default value.
TIMING ERROR (13 characters)	1. This message is sent in I.BUR mode to indicate timing error when: BUR x 1/FRQ > RPT where BUR = Burst number FRQ = 8116A frequency setting RPT = Burst repetition time 2. 8116A hardware detects this error condition which causes the output to change. 3. SRQ can be suppressed for this error via the HP-IB message "SR0". In this case, the first bit of the HP-IB status byte is still set to '1' during error condition. "SR0" is the 8116A's default value.
NOTE: The 8116A can output more than one error message in response to a single 'IERR' command. e.g. "WAVEFORM ERROR WIDTH ERROR". When multiple errors are suspected, be sure to dimension enough memory space to accommodate the possible character strings.	

Table 3–7. Programming Error Messages (Response to interrogate error statement 'IERR')

ASCII String	Comments
HANDLING ERROR (15 characters)	1. A handling error occurs when: a) User attempts to select Autovernier operation ("A1") when the 8116A is not in NORM ("M1") mode. b) User attempts to exit NORM mode (e.g. program "M2" for TRIG mode) with Autovernier operation selected. The 8116A output changes to correspond to the new mode. c) User attempts to program a parameter value outside the 8116A specification limits. e.g. "HIL 20 V". The 8116A output remains unchanged during the error condition, and front panel LED's blink to indicate the erroneous settings.
LEVEL ERROR (12 characters)	1. This message is sent when either of the following conditions are not observed: a) For amplitudes ≥ 100 mV, the HIL/LOL voltage window is ± 8.00 V. b) For amplitudes ≤ 100 mV, the HIL/LOL voltage window is ± 800 mV. Error detection is determined via the following formula: HIL = OFS + 1/2 AMP LOL = OFS – 1/2 AMP 2. The 8116A output remains unchanged during the error condition.
LIMIT ERROR (12 characters)	1. Conditions are described for 'LEVEL ERROR' except that the HIL/LOL window is determined by the currently active levels when LIMIT operation is selected.
NOTE: The 8116A can output more than one error message in response to a single 'IERR' command e.g. "HANDLING ERROR LEVEL ERROR". When multiple errors are suspected, be sure to dimension enough memory space to accommodate the possible character strings.	

3–76 Universal HP-IB Commands

3–77 The 8116A will respond to the universal commands listed in Table 3–8, which are sent in the command modes (ATN true).

Table 3–8. HP-IB Universal Commands

Mnemonic	Command	ASCII Code
DCL	Device Clear	DC4
LLO	Local Lockout	DC1
MLA	My Listen Address	(selectable)
MTA	My Talk Address	(selectable)
SPD	Serial Poll Disable	EM
SPE	Serial Poll Enable	CAN
UNL	Unlisten	?
UNT	Untalk	–
GET	Group Execute Trigger	BS
GTL	Go to Local	SOH
SDC	Selected Device Clear	EOT

3–78 Local, Remote and Local Lockout

3–79 Local Capability. In local mode, the 8116A can communicate on the bus by sending a Status Byte indicating 'autovernier in process' or 'sweep in process'., as well as responding to the Remote Message.

3–80 Remote Capability. In remote mode, the 8116A's front panel controls are disabled except the LINE switch, LCL key and LEVEL adjust. When addressed to listen, the 8116A will respond to the following bus messages: Data, Trigger, Clear, Remote, Local, Local Lockout, Clear Lockout/Set Local and Abort. When addressed to talk, the 8116A will send one of the following messages: Data, Require Service, or Status Byte.

3–81 The RMT LED is on when the 8116A is in remote mode. The ADS LED is on when the 8116A is currently addressed to talk or listen. The 8116A front panel digital display shows the value of the last programmed parameter.

3–82 Local-to-Remote Change. The 8116A switches to remote upon receipt of the two part Remote Message. The two parts are:

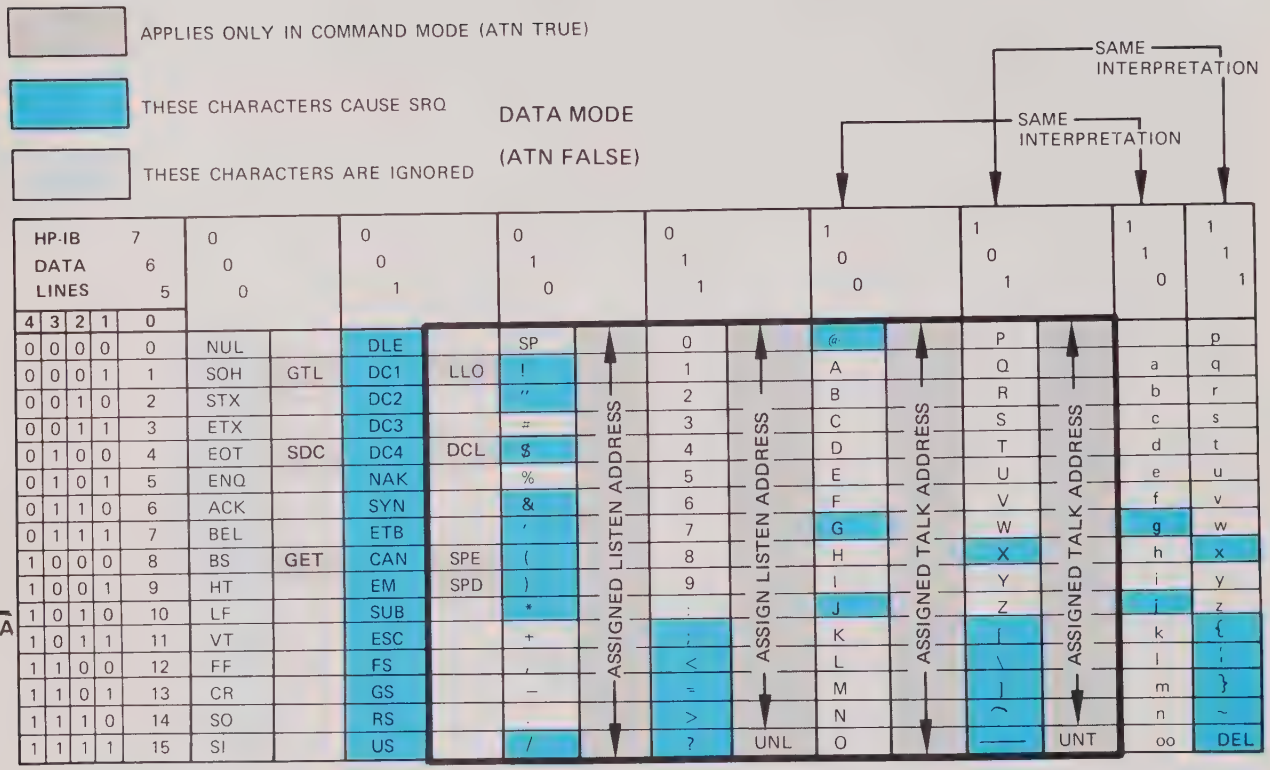
Remote Enable (REN)
Addressed to Listen or Talk (MLS or MTA)

The 8116A's output signal and all control settings remain unchanged with the local-to-remote transition.

3–83 Remote-to-Local Change. The 8116A returns to local control upon receipt of the Local or Clear Lockout/Set Local message. It can also be set to local by pressing the front panel LCL key (assuming that local lockout is not in effect). The output signal and all control settings remain unchanged with the remote-to-local transition.

3–84 Local Lockout. When a data transmission is interrupted, which can happen by returning the 8116A to local with the front panel LCL key, the data could be lost. This would leave the 8116A in an unknown state. To prevent this, a local lockout is recommended to disable the LCL key. Local lockout remains in effect until the 8116A is returned to the local state by either turning the LINE switch off/on or by programming the Local Message.

Table 3–9. Code Assignments (ASCII) for the 8116A



SECTION IV
PERFORMANCE TESTS

4–1 INTRODUCTION

4–2 The procedures in this section test the electrical performance of the instrument using the specifications of Table 1–2 as performance standards. All tests can be performed without access to the interior of the instrument.

4–3 EQUIPMENT REQUIRED

4–4 Equipment required for the performance tests is listed in Table 1–1, Recommended Test Equipment. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

4–5 TEST RECORD

4–6 Results of the performance tests may be tabulated on the Test Record at the end of the test procedures. The Test Record lists all of the tested specifications and their acceptable limits. Test results recorded at incoming inspection can be used for comparison in periodic maintenance, troubleshooting, and after repairs or adjustments.

4–7 PERFORMANCE TESTS

4–8 The performance tests given in this section are suitable for incoming inspection, troubleshooting, or preventive maintenance. During any performance test, all shields and connecting hardware must be in place. The tests are designed to verify the published instrument specifications, perform the tests in the order given and record the data on the Test Record at the end of the test procedures.

4–9 Each test is arranged so that the specification is written as it appears in Table 1–2. Next, when necessary, a description of the test and any special instructions or problem areas are included. Each test that requires test equipment has a setup drawing and a list of the required equipment. The initial steps of each procedure give control settings required for that particular test.

PERFORMANCE TESTS

4–10 FREQUENCY

SPECIFICATION

1.00 mHz to 50 MHz

(1 mHz to 999 kHz for 10 % and 90 % duty cycle)

(1 mHz to 9,99 MHz for 20 % and 80 % duty cycle)

Accuracy in Norm input mode:

% of setting	Pulse mode or 50 % duty cycle	≠ 50 % duty cycle
1 mHz to 99,9 kHz	± 3 %	± 3 %
100 kHz to 9,99 MHz	± 5 %	± 10 %
10 MHz to 50 MHz	± 5 %	–

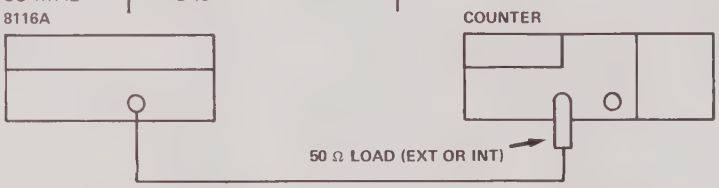


Figure 4–1. Test Setup for Frequency, Burst and Sweep

EQUIPMENT

Counter
Cable Assembly BNC (61 cm)
Feedthrough Termination 50 Ω (if necessary)

PROCEDURE

1. Connect equipment as shown in Figure 4–1.

2. Set 8116A as follows:

INPUT MODE	NORM
FUNCTION	SQUARE
DUTY CYCLE	50 %
CTRL	OFF
AMPL	1 V
OFFSET	0 V
OUTPUT MODE	NORM

3. Set counter to frequency measurement.

4. Set 8116A frequency and verify counter frequency reading as follows:

8116A setting	Counter reading
50,0 MHz	50.0000 MHz ± 2500 kHz
10,0 MHz	10.0000 MHz ± 500 kHz
10,0 kHz	10.0000 kHz ± 300 Hz
1,0 kHz	1.00000 kHz ± 30 Hz

5. Set 8116A frequency and verify counter period reading as follows:

8116A setting	Counter reading
1.00 Hz	1.00000 s ± 33.3 ms
100 mHz	10.00000 s ± 333 ms

PERFORMANCE TESTS

4–11 PULSE WIDTH (pulse mode)

SPECIFICATION

10 ns to 999 ms
Accuracy ± 5 % of setting ± 2 ns

EQUIPMENT

Counter
Cable Assembly BNC
Feedthrough Termination (if necessary)

PROCEDURE

1. Connect equipment as shown in Figure 4–1.

2. Set 8116A as follows:

INPUT MODE	NORM
FUNCTION	PULSE
CTRL	OFF
FRQ	1 MHz
AMP	1 V
OFS	0 V

3. Set counter to TI, COMM, CH A +, CH B –

4. Set 8116A width /frequency as shown and verify counter width reading.

FREQUENCY	WIDTH	COUNTER READING
1 MHz	100 ns	93 ns – 107 ns
100 KHz	1 µs	948 ns – 1052 ns
1 KHz	100 µs	95 µs – 105 µs
10 Hz	1 ms	~~995~~ 935 µs – 1050 µs
1 Hz	500 ms	475 ms – 525 ms

PERFORMANCE TESTS

4–12 BURST (Option 001 only)

SPECIFICATION

A pre-programmed number of output cycles is generated on receipt of an input trigger signal or manual command, min time between bursts: 100 ns. Burst length: 1 to 999 cycles.

EQUIPMENT

Counter
Cable Assembly BNC (61 cm)
Feedthrough Termination 50 Ω (if necessary).

PROCEDURE

1. Load Burst number 816 into 8116A.

2. Set 8116A as follows:

INPUT MODE	EXT BURST
FUNCTION	SQUARE
DUTY CYCLE	50 %
CTRL	OFF
FRQ	10 kHz
AMPL	1 V
OFFSET	0 V
BURST	816
OUTPUT MODE	NORM

3. Use Figure 4–1 test setup and set counter to START.

4. Press 8116A's MAN button and verify that counter now displays the set number (816) of output cycles. (5345A reading will be 815, since first pulse arms the counter).

PERFORMANCE TESTS

4–13 AMPLITUDE AND OFFSET

SPECIFICATION

Amplitude and offset are independently variable within the following two level windows.

Level window	± 800 mV	± 8.00 V
Amplitude range	10.0 mVpp to 99.9 mVpp	100 mVpp to 16.0 Vpp
Ampl. resolution	3 digits	3 digits
Ampl. accuracy*	± 5 % (0.26 dB)	± 5 % (0.26 dB)
Repeatability	Factor 4 better than accuracy	
Offset range	0 to ± 795 mV	0 to ± 7.95 V
Offset resolution	3 digits (best case 100 μV)	3 digits (best case 1 mV)
Offset accuracy	± 0.5 % of setting ± 1 % of amplitude ± 2 mV	± 0.5 % of setting ± 1 % of amplitude ± 40 mV
Repeatability	Factor 4 better than accuracy	

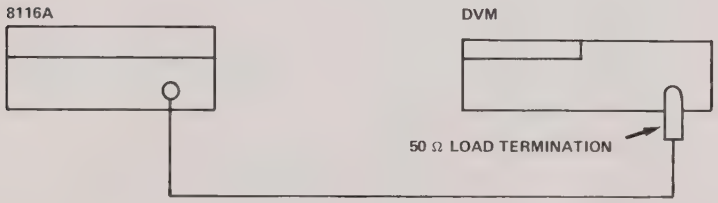


Figure 4–2. Test Setup for Amplitude and Offset

EQUIPMENT

Digital Voltmeter
Cable Assembly BNC (1 x 61 cm)
Feedthrough Termination 50 Ω

If total error is > ± .5 % of nominal, note deviation and take into account during measurement.

PROCEDURE

1. Connect the equipment as shown in Figure 4–2.

2. Set 8116A as follows:

INPUT MODE	NORM
FUNCTION	SINE
DUTY CYCLE	50 %
CTRL	OFF
FRQ	1,0 kHz
OFFSET	0 V
OUTPUT MODE	NORM

PERFORMANCE TESTS

OUTPUT MODE	AMPL	FUNCTION	DVM Reading *
50 Ω	8.00 V	Sine	2,69 – 2,97 V
		triangle	2,19 – 2,43 V
		square	3,8 – 4,2 V
50 Ω	3.00 V	Sine	1,008 – 1,114 V
		triangle	0,823 – .909 V
		square	1,425 – 1,575 V
50 Ω	1.00 V	Sine	0,336 – 0,372 V
		triangle	0,275 – 0,303 V
		square	0,475 – 0,525 V
50 Ω	100 mV	Sine	33,6 – 37,1 mV
		triangle	27,4 – 30,3 mV
		square	47,5 – 52,5 mV

3. Set 8116A to TRIG mode.

4. Using best DVM resolution, measure the dc voltages for the following 8116A settings:

OUTPUT MODE	OFFSET	DVM Reading *
50 Ω	7.5 V	7,421 – 7,578 V
50 Ω	5.00 V	4,934 – 5,066 V
50 Ω	3.00 V	2,944 – 3,056 V
50 Ω	1.00 V	0,954 – 1,046 V
50 Ω	100 mV	58 mV– 142 mV

* last digit rounded

PERFORMANCE TESTS

4–14 SINE CHARACTERISTICS

SPECIFICATION

Total Harmonic Distortion (THD): < 1 % (–40 dB),
(10 Hz to 50 kHz)
Harmonic Signals: More than 34 dB below fundamental (50 kHz to 1 MHz).
More than 23 dB below fundamental (1 MHz to 50 MHz, < 8 Vpp amplitude).

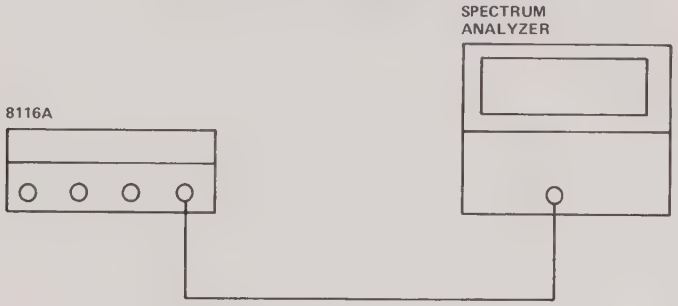


Figure 4–3. Test Setup for Sine Characteristics

EQUIPMENT

Spectrum analyzer
Cable assembly BNC (1 x 61 cm)

PROCEDURE

1. Connect the equipment as shown in Figure 4–3.

2. Set 8116A as follows:

INPUT MODE	NORM
FUNCTION	SINE
DUTY CYCLE	50 %
CTRL	OFF
FRQ	1 kHz
AMPL	8 V
OFFSET	0 V
OUTPUT MODE	NORM

3. Tune spectrum analyzer for minimum display amplitude. Adjust gain so that fundamental corresponds to 0 dB. Verify that the 2nd and 3rd harmonics do not exceed the –42 and –47 dB levels, respectively.

PERFORMANCE TESTS

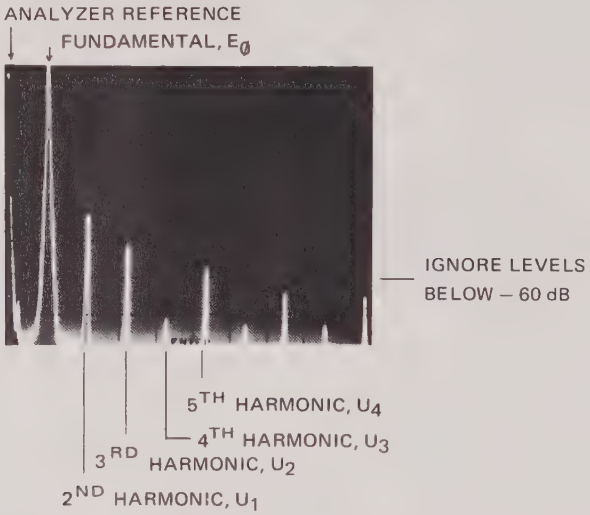


Figure 4–4. Typical Spectrum Analyzer Display at 1 KHz

The value of harmonics may differ between instruments.

4. Verify that THD $<$ 1 %

$$THD = \frac{\sqrt{E_1^2 + E_2^2 + E_3^2 + \ldots\ldots}}{E_0} \cdot 100\ \%$$

where E_0 = fundamental voltage amplitude and E_1, E_2 etc are the 2nd, 3rd etc harmonic amplitudes.

When the harmonics are expressed in dB the formula becomes:

$$THD = \sqrt{10^{\frac{A_1}{10}} + 10^{\frac{A_2}{10}} + 10^{\frac{A_3}{10}} + \ldots\ldots} \cdot 100\ \%$$

where A_1 = first harmonic in dB etc.

5. Set 8116A FRQ to 50 MHz.

6. Tune spectrum analyzer for minimum display amplitude. Adjust gain so that fundamental corresponds to 0 dB. Verify that no harmonics exceed the –23 dB level.

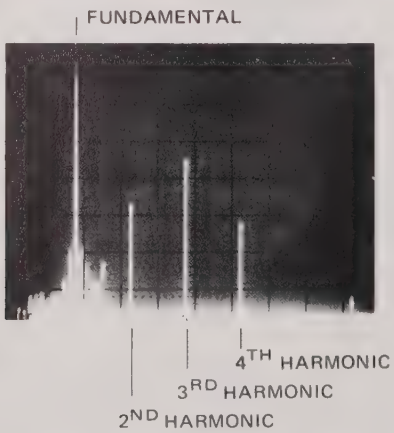


Figure 4–5. Typical Spectrum Analyzer Display at 50 MHz, NORM

The value of harmonics may differ between instruments.

PERFORMANCE TESTS

4–15 PULSE CHARACTERISTICS

SPECIFICATION

Transition times (10 % to 90 %): < 6 ns

Preshoot/Overshoot/Ringing: ± 5 %

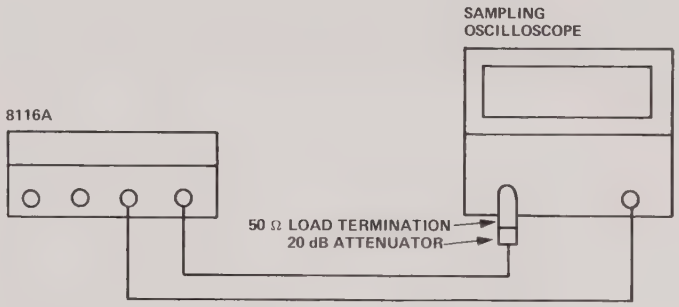


Figure 4–6. Test Setup for Pulse Characteristics

EQUIPMENT

Sampling oscilloscope
Cable assembly BNC (2 x 61 cm)
Feedthrough termination 50 Ω
Power attenuator 20 dB, 20 W

PROCEDURE

1. Connect the equipment as shown in Figure 4–6.

2. Set the 8116A as follows:

INPUT MODE	NORM
FUNCTION	SQUARE
DUTY CYCLE	50 %
CTRL	OFF
FRQ	1 MHz
AMPL	8 V
OFFSET	0 V
OUTPUT MODE	NORM

3. Set scope so that one cycle fills the display and measure:

leading edge (risetime)	⩽ 6 ns
trailing edge (risetime)	⩽ 6 ns
preshoot	⩽ ± 5 % of amplitude *
overshoot and ringing	⩽ ± 5 % of amplitude *

* note possible sampling error

PERFORMANCE TESTS

4–16 TRIGGER, GATE and E.WIDTH PERFORMANCE

SPECIFICATION

Trig: pos. ext input pulse ⩾ 10 ns wide generates one output cycle.
Sensitivity: 500 mVpp
Gate: Ext. signal enables oscillator. First output cycle synchronous with active trigger slope.
Last cycle always completed.
E.Width: External signal will be shaped to determine output pulse width and period. (Pulse mode only).
Max. input: ± 20 V
Input impedance: 10 kΩ typical

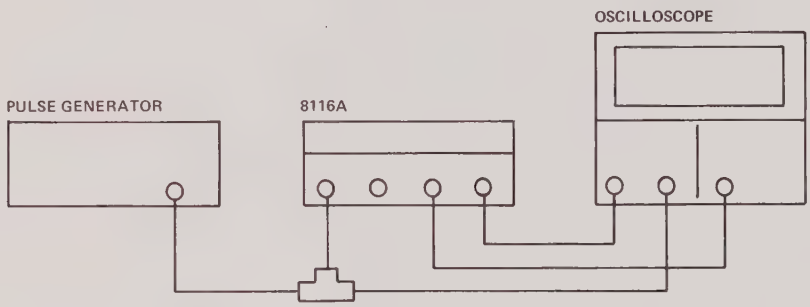


Figure 4–7. Test Setup for Burst Gate and Trigger Performance

EQUIPMENT

Pulse generator
Oscilloscope
Cable assembly (3 x 61 cm, 2 x 30 cm)
BNC Tee,
Feedthrough termination 50 Ω

PROCEDURE

1. Connect the equipment as shown in Figure 4–7.

2. Set the 8116A as follows:

INPUT MODE	TRIG
FUNCTION	SINE
DUTY CYCLE	50 %
CTRL	OFF
FRQ	60 KHz
AMPL	1 V
OFFSET	0 V
OUTPUT MODE	NORM
EXT INPUT	⫡

PERFORMANCE TESTS

3. Set ext. function generator for output pulse approx 50 μs wide, rep. rate 10 kHz, baseline zero or more negative, pulse top + 1 V. Adjust 8116A trigger input level for correct trigger. Verify that each trigger pulse generator one complete output cycle (Figure 4–8).

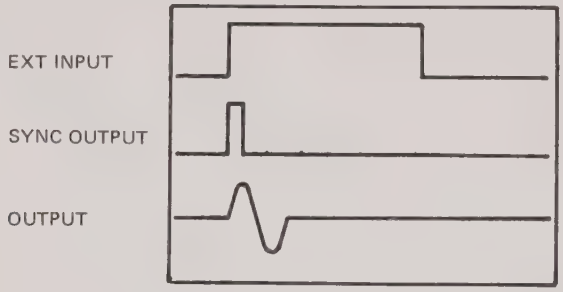


Figure 4–8. Example of correct trigger operation

4. Set 8116A to GATE mode. Verify that each positive gate releases a burst of output cycles and that each cycle is complete (Figure 4–9).

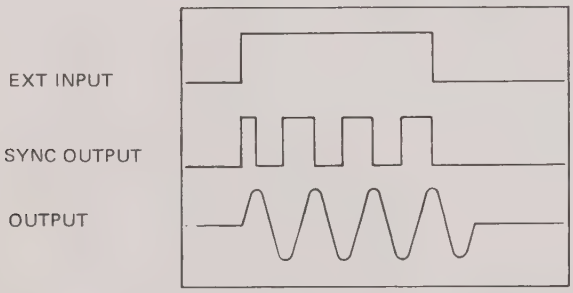


Figure 4–9. Example of correct gate operation

5. Set 8116A waveform to PULSE and mode to E.WIDTH. Verify that each external pulse releases a pulse of same width.

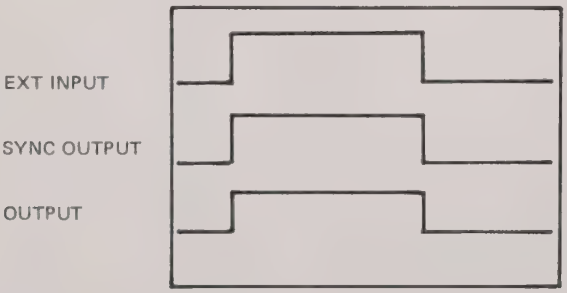


Figure 4–10. Example of correct E.Width operation

PERFORMANCE TESTS

4–17 FM

SPECIFICATION

Output is frequency modulated by an external voltage applied to a rear panel BNC, 1 V modulates 1 % deviation.

Deviation: ± 5 % max

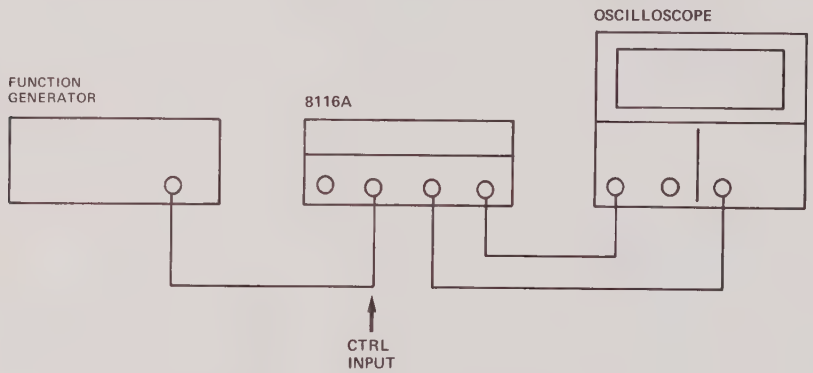


Figure 4–11. Test Setup for FM

EQUIPMENT

Oscillator
Oscilloscope
Cable assembly BNC (3 x 61 cm)

PROCEDURE

1. Connect the equipment as shown in Figure 4–11.

2. Set oscillator to 10 kHz, 2 Vpp

3. Set oscilloscope to 0,1 µs/div timebase, Magnifiere X10

4. Set the 8116A as follows:

INPUT MODE	NORM
FUNCTION	SQUARE
DUTY CYCLE	50 %
CTRL	FM
FRQ	1 MHz
AMPL	1 V
OFFSET	0 V
OUTPUT MODE	NORM

5. Check the delayed sweep for a typical jitter of 2 div ± 10 %.

PERFORMANCE TESTS

4–18 AMPLITUDE MODULATOR

SPECIFICATION

0 to 5 V_{pp} modulates 0 to 100 % modulation depth.
Modulating Frequency: dc to 1 MHz (−3 dB).
Input impedance: 10 kΩ typical.
Envelope Distortion: (dc to 50 kHz mod. freq.):

Carrier	Modulation		Distortion
⩽ 1 MHz	0 to 90 %		< 1 %
> 1 MHz	0 to 30 %	<	< 3 %

Carrier Frequency Deviation: < 0.01 %, 0 to 30 % modulation.

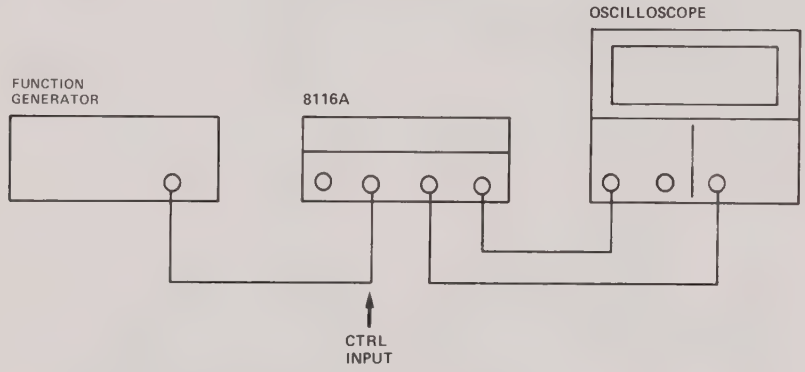


Figure 4–12. CTRL Input

EQUIPMENT

Function Generator
Oscilloscope

PROCEDURE

1. Connect the equipment as shown in Figure 4–12.

2. Set the 8116A as follows:

INPUT MODE	NORM
FUNCTION	SINE
DUTY CYCLE	50 %
CTRL	AM
FRQ	100 kHz
AMPL	1 V
OFFSET	0 V
OUTPUT MODE	NORM

3. Set oscillator for 1 kHz and 5 Vpp amplitude.

4. The display should be of a modulation depth of 100 %.

PERFORMANCE TESTS

4–19 HP-IB CAPABILITY

SPECIFICATION

Accuracy: See Frequency Characteristics, Output Characteristics.

Programming Times
Listen (time for 8116A to receive and verify message)
Modes, Waveforms, Norm/Complement,
Disable/Enable: 30 ms
Frequency, Duty Cycle, Width: 50 ms
Amplitude, Offset, Levels: 250 ms

Talk (time for 8116A to transmit a message)
Status: 1 byte (indicates nature of programming error): 15 ms
Learn: 10 lines (16 with Opt. 001) up to 14 characters plus CRLF: 15 ms/line average

Settling Times (time to execute message)
Frequency, Duty Cycle, Width, Amplitude: 5 ms
Offset, DC Voltage: 30 ms

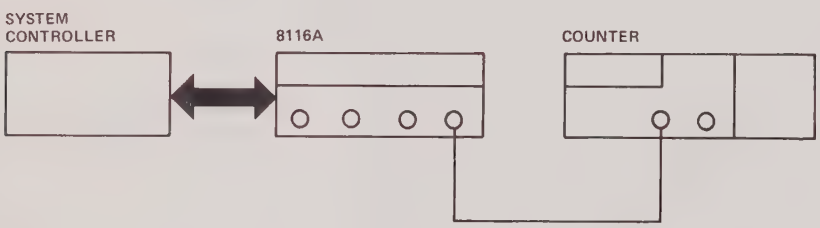


Figure 4–13. Test Setup for HP-IB Operation

EQUIPMENT

System controller
Counter
Cable assembly (1 x 61 cm)

PROCEDURE

1. Connect the equipment as shown in Figure 4–13.

2. Type following line in:

BASIC	HPL
OUTPUT 716; "FRQ 440 Hz"	wrt 716, "FRQ 440 Hz"
press EXECUTE (END LINE)	press EXECUTE

3. Check counter reading for 440 Hz and the REMOTE LED is on.

PERFORMANCE TESTS

Table 4–4. Performance Test Record (1 of 2)

Hewlett-Packard Company
Model 8116A/8116A Option 001
Programmable Signal Source
Serial No. _____ Tested By _____
Date _____

Para. No.	Test Description			Results Min	Actual	Max
4–10	Frequency					
		50.0 MHz		47,5 MHz	_____	52,5 MHz
		10.0 MHz		9,5 MHz	_____	10,5 MHz
		10.0 kHz		9,7 kHz	_____	10,3 kHz
		1.00 kHz		0,97 kHz	_____	1,03 kHz
		1.00 Hz		0,967 ms	_____	1,033 ms
		100 mHz		9,66 ms	_____	10,33 ms
4–11	Pulse Width					
		100 ns		93 ns	_____	107 ns
		1 µs		948 ns	_____	1052 ns
		100 µs		95 µs	_____	105 µs
		1 ms		995 µs	_____	1050 µs
		500 ms		475 ms	_____	525 ms
4–12	Burst (Option 001) only Number of actual output cycles same as set burst length ?				yes/no	
4–13	Amplitude and Offset					
	OUTPUT MODE	AMPL	FUNCTION			
	50 Ω	5.00 V	sine *	2.69 V	_____	2.97 V
			triangle *	2.19 V	_____	2.43 V
			square *	3.8 V	_____	4.2 V
	50 Ω	3.00 V	sine *	1.008 V	_____	1.114 V
			triangle *	0.823 V	_____	0.909 V
			square *	1.425 V	_____	1.575 V
	50 Ω	1.00 V	sine *	0.336 V	_____	0.372 V
			triangle *	0.275 V	_____	0.303 V
			square *	0.475 V	_____	0.525 V
	50 Ω	100 mV	sine *	33.6 mV	_____	37.1 mV
			triangle *	27.4 mV	_____	30.3 mV
			square *	47.5 mV	_____	52.5 mV

PERFORMANCE TESTS

Table 4–4. Performance Test Record (2 of 2)

Para. No.	Test Description	Results		
		Min	Actual	Max
	OUTPUT MODE / OFFSET			
	50 Ω 7.5 V	7.421 V	_____	7.578 V
	50 Ω 5.00 V	4.934 V	_____	5.066 V
	50 Ω 3.00 V	2.944 V	_____	3.056 V
	50 Ω 1.00 V	0.954 V	_____	1.046 V
	50 Ω 100 mV	58mV	_____	142mV
4–14	Sine Characteristics (Harmonic level)			
	FRQ = 1 kHz (2^{nd} harmonic)		_____	–42 dB
	FRQ = 1 kHz (3^{rd} harmonic)		_____	–47 dB
	FRQ = 1 MHz (THD)		_____	1 %
	FRQ = 50 MHz (worst harmonic)		_____	–23 dB
4–15	Pulse Characteristics			
	Leading edge		_____	⩽ 6 ns
	Trailing edge		_____	⩽ 6 ns
	Preshoot	⩽ –5 %	_____	⩽ +5 %
	Overshoot and ringing	⩽ –5 %	_____	⩽ +5 %
4–16	Trigger, Gate, E.Width			
	Positive trigger releases one complete output cycle ?		_____ yes/no	
	Positive gate releases a burst of output cycles, fast cycle complete ?		_____ yes/no	
	Positive pulse releases a pulse of same width ?		_____ yes/no	
4–17	FM Mode Jitter, FM on		_____	
4–18	Amplitude Modular Modulation depth 100 %		_____ yes/no	
4–19	HP-IB Capability Functionally ? Settling accuracy: 440 Hz		_____ yes/no _____	

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08116–90000

Printed in the Federal Republic of Germany